US005742905A

United States Patent [19]

Pepe et al.

[11] Patent Number: 5,742,905

[45] Date of Patent: Apr. 21, 1998

[54] **PERSONAL COMMUNICATIONS INTERNETWORKING**

[75] Inventors: **David Matthew Pepe**, Middletown; **Lisa B. Blitzer**, Manalapan; **James Joseph Brockman**, Perrineville; **William Cruz**, Eatontown; **Dwight Omar Hakim**, Matawan, all of N.J.; **Michael Kramer**, Bronx County, N.Y.; **Dawn Diane Petr**, Basking Ridge, N.J.; **Josefa Ramaroson**, Freehold, N.J.; **Gerardo Ramirez**, Bridgewater, N.J.; **Yang-Wei Wang**, Howell, N.J.; **Robert G. White**, Morristown, N.J.

[73] Assignee: **Bell Communications Research, Inc.**, Morristown, N.J.

[21] Appl. No.: **309,336**

[22] Filed: **Sep. 19, 1994**

[51] **Int. Cl.**[6] **H04Q 7/20**

[52] **U.S. Cl.** **455/461**; 455/445; 455/417; 379/210

[58] **Field of Search** 379/56, 57, 58, 379/63, 210, 211, 212, 213, 214, 142, 67, 88, 201, 207, 229; 455/403, 414, 417, 445, 422, 461

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,644,351	2/1987	Zabarsky et al.	340/825.44
5,029,196	7/1991	Morganstein	379/67
5,090,050	2/1992	Heffernan	379/58 X
5,109,405	4/1992	Morganstein	379/67 X
5,311,570	5/1994	Grimes et al.	379/57
5,327,486	7/1994	Wolff et al.	379/96
5,329,578	7/1994	Brennan et al.	379/67
5,353,331	10/1994	Emery et al.	379/58
5,467,390	11/1995	Brankley et al.	379/229
5,479,411	12/1995	Klein	379/88 X
5,479,472	12/1995	Campana, Jr. et al.	379/58
5,559,860	9/1996	Mizikovsky	379/58

FOREIGN PATENT DOCUMENTS

2193861 8/1987 United Kingdom .

OTHER PUBLICATIONS

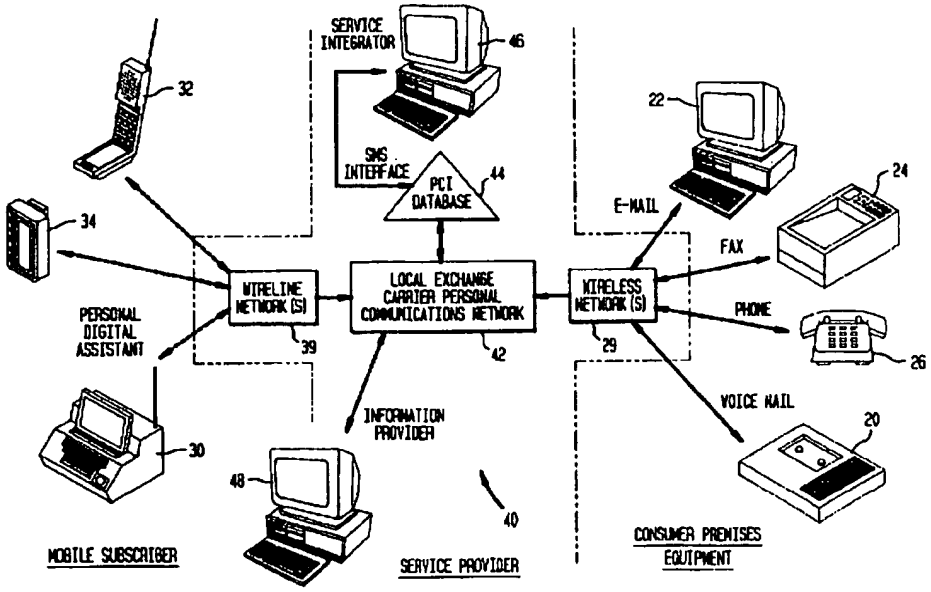
Hientz et al., A Short Message Service—A New Service of Digital Mobile Communication, pp. 517–526, Sep. 1993.

Primary Examiner—Dwayne Bost
Assistant Examiner—William G. Trost
Attorney, Agent, or Firm—Loria B. Yeadon; Joseph Giordano

[57] **ABSTRACT**

A person communications internetworking provides a network subscriber with the ability to remotely control the receipt and delivery of wireless and wireline voice and text messages. The network operates as an interfaces between various wireless and wireline networks, and also performs media translation, where necessary. The subscriber's message receipt and delivery options are maintained in a database which the subscriber may access by wireless or wireline communications to update the options programmed in the database. The subscriber may be provided with CallCommand service which provides real-time control of voice calls while using a wireless data terminal or PDA.

11 Claims, 26 Drawing Sheets



08/04/2003, EAST Version: 1.04.0000

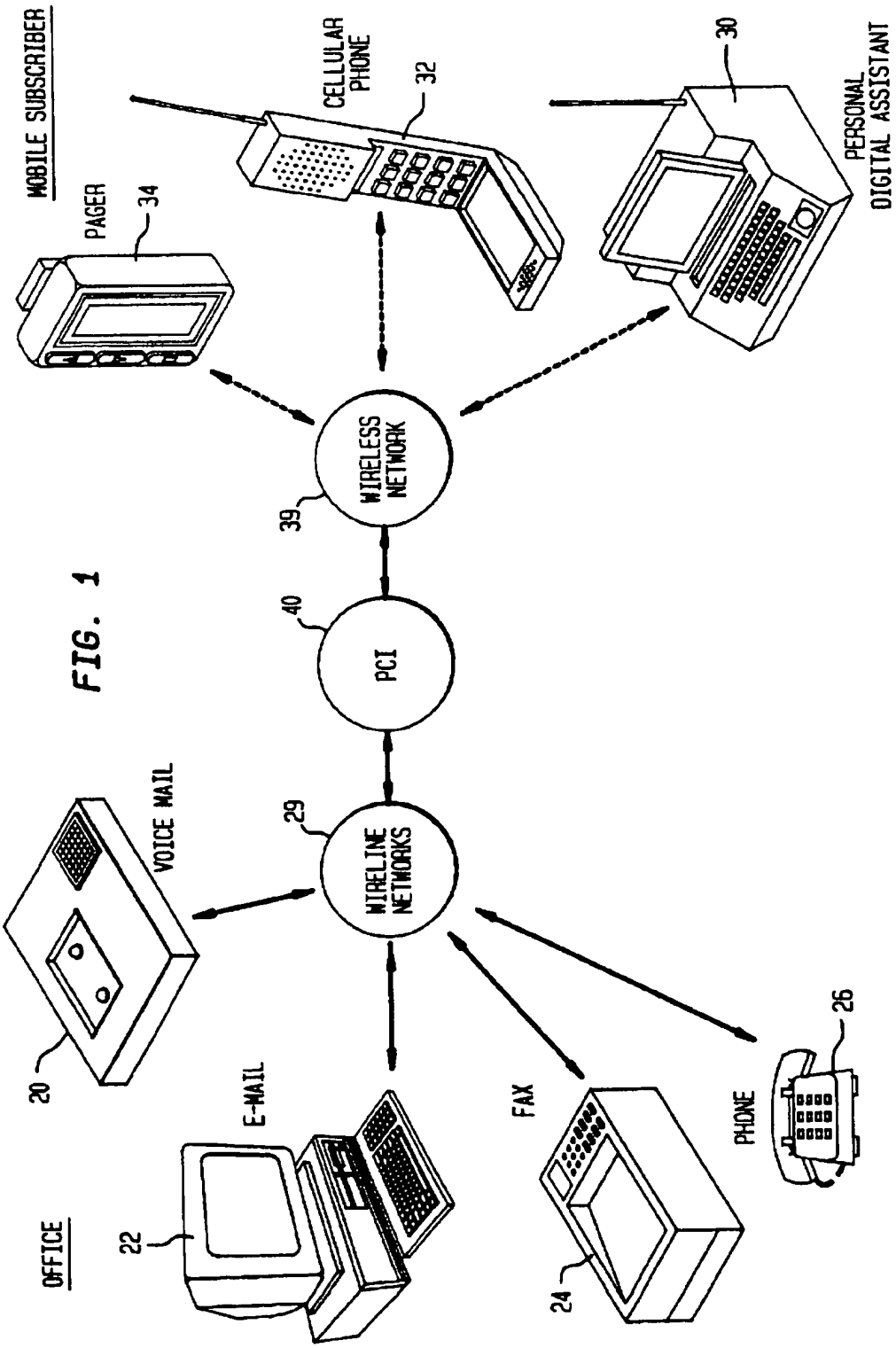

MOBILE SUBSCRIBER
PAGER
34
CELLULAR PHONE
32
30
PERSONAL DIGITAL ASSISTANT
WIRELESS NETWORK
39
PCI
40
WIRELINE NETWORKS
29
VOICE MAIL
20
E-MAIL
22
OFFICE
FAX
24
PHONE
26

FIG. 1

FIG. 2

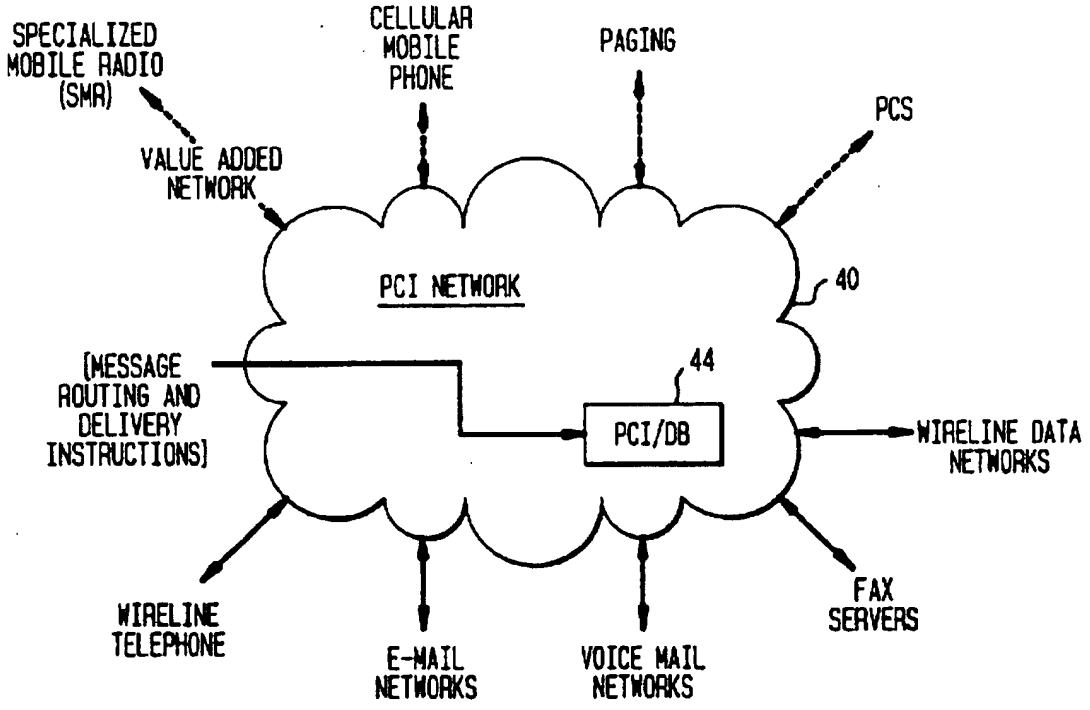
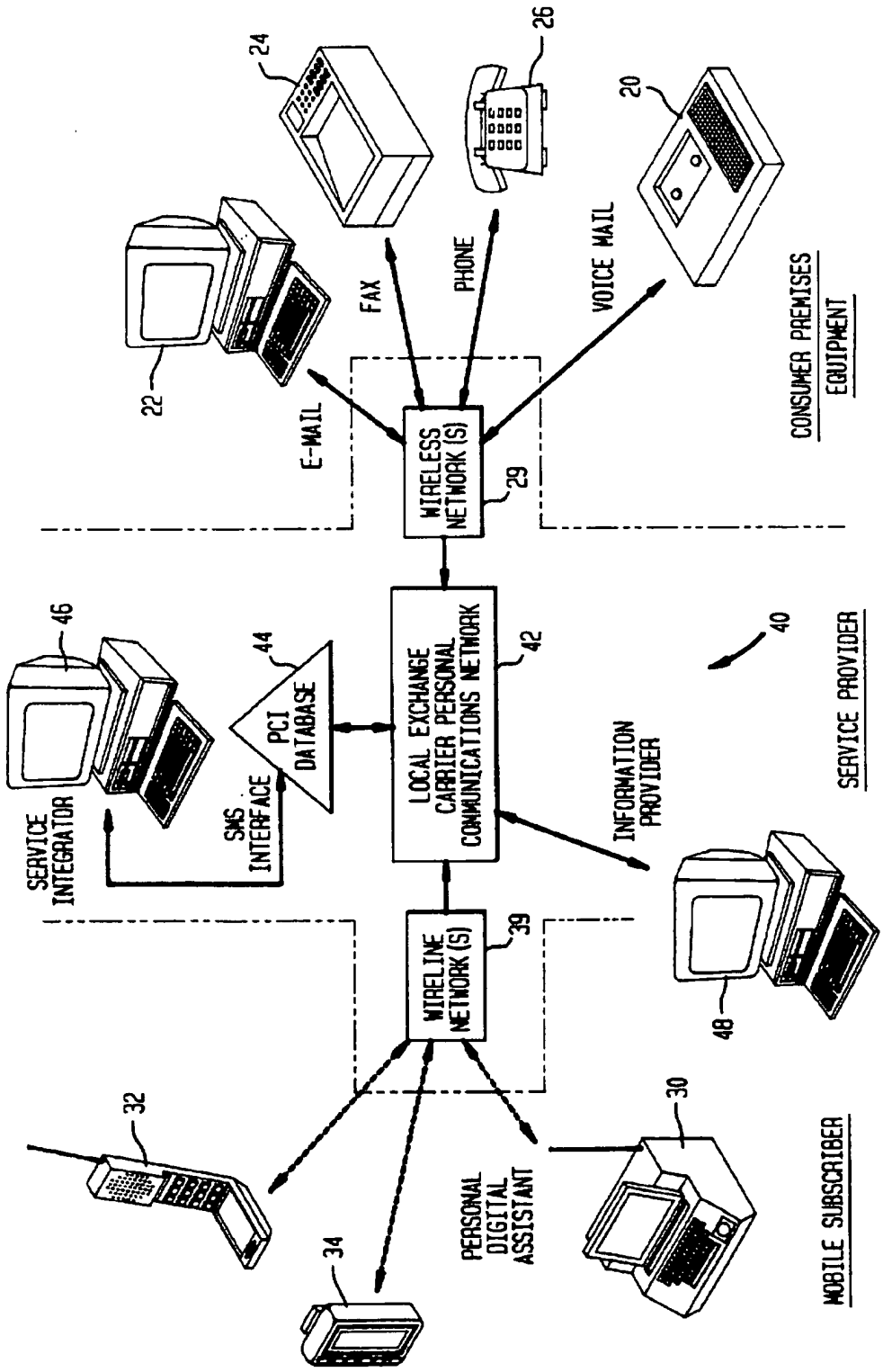

SPECIALIZED MOBILE RADIO (SMR)
CELLULAR MOBILE PHONE
PAGING
PCS
VALUE ADDED NETWORK
PCI NETWORK
40
44
[MESSAGE ROUTING AND DELIVERY INSTRUCTIONS]
PCI/DB
WIRELINE DATA NETWORKS
WIRELINE TELEPHONE
E-MAIL NETWORKS
VOICE MAIL NETWORKS
FAX SERVERS

FIG. 3


24
26
20
22
FAX
PHONE
VOICE MAIL
E-MAIL
WIRELESS NETWORK (S)
29
CONSUMER PREMISES EQUIPMENT
46
44
PCI DATABASE
LOCAL EXCHANGE CARRIER PERSONAL COMMUNICATIONS NETWORK
42
40
SERVICE INTEGRATOR
SMS INTERFACE
INFORMATION PROVIDER
SERVICE PROVIDER
WIRELINE NETWORK (S)
39
48
32
30
PERSONAL DIGITAL ASSISTANT
34
MOBILE SUBSCRIBER

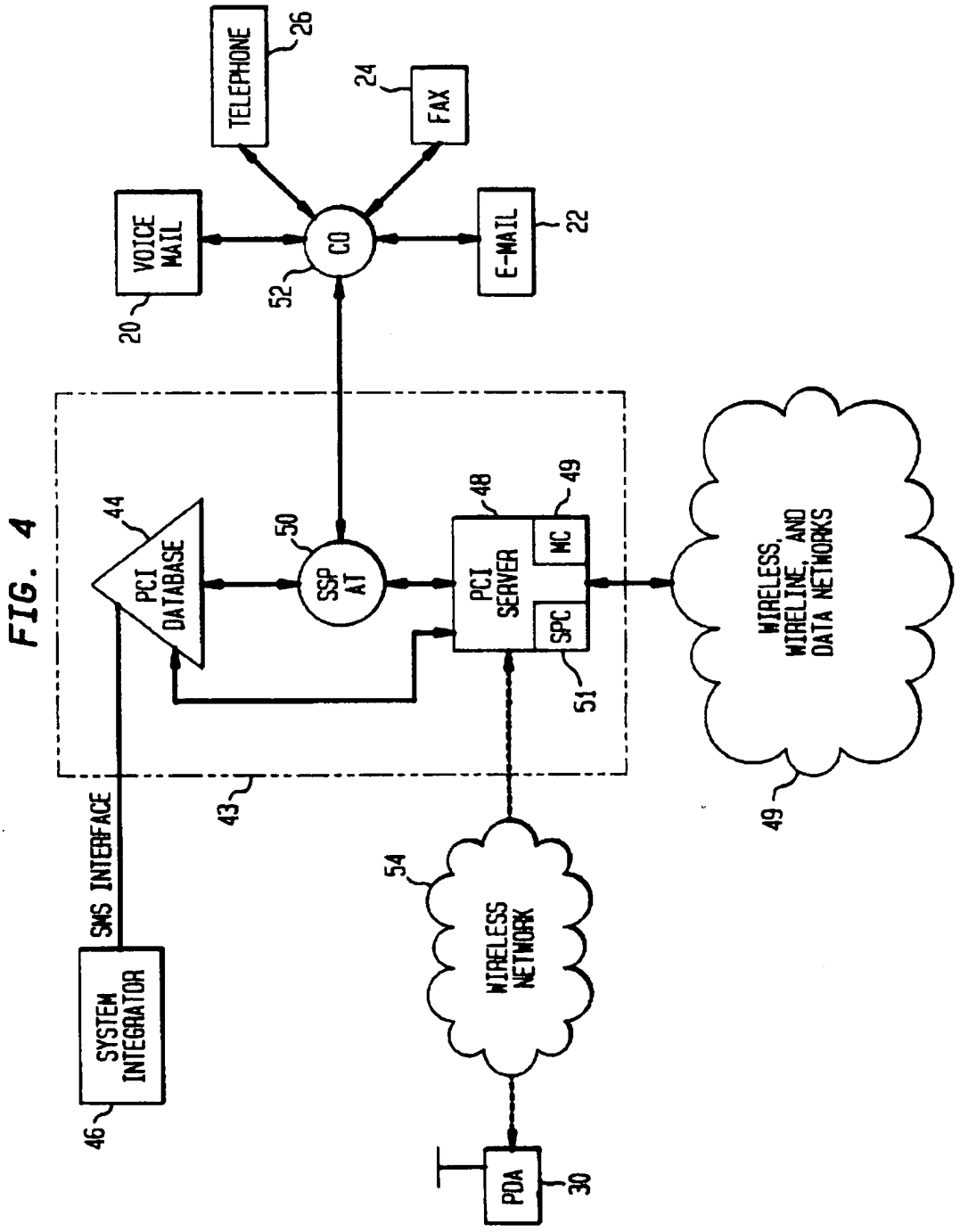

TELEPHONE
26
FAX
24
VOICE MAIL
20
CO
52
E-MAIL
22
PCI DATABASE
44
SSP AT
50
PCI SERVER
48
MC
49
SPC
51
WIRELESS, WIRELINE, AND DATA NETWORKS
49
43
SMS INTERFACE
SYSTEM INTEGRATOR
46
WIRELESS NETWORK
54
PDA
30

FIG. 4

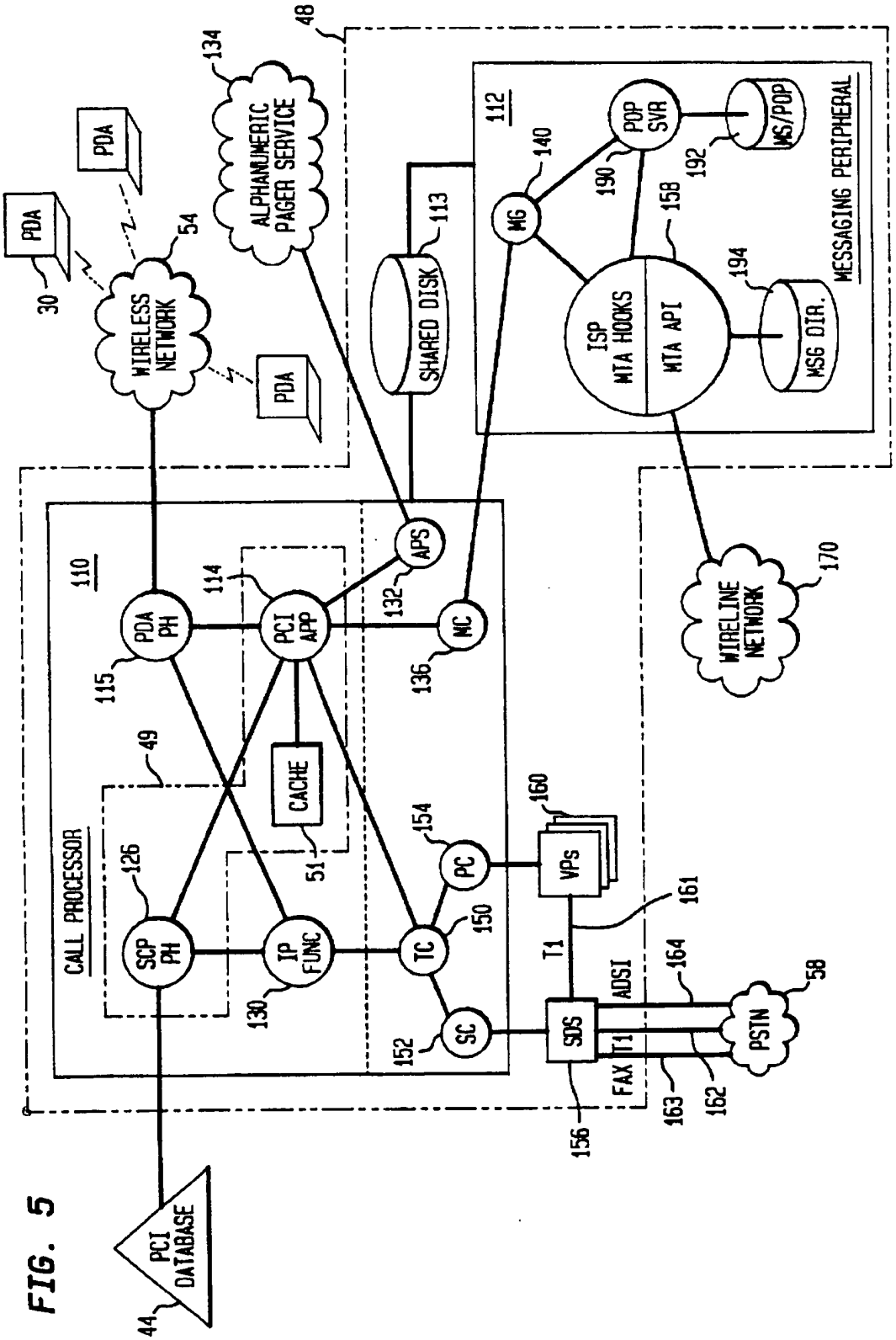

48
134
ALPHANUMERIC PAGER SERVICE
PDA
PDA
PDA
30
54
WIRELESS NETWORK
SHARED DISK
113
112
MG
140
POP SVR
190
MS/POP
192
158
ISP MTA HOOKS
MTA API
194
MSG DIR.
MESSAGING PERIPHERAL
110
APS
132
PDA PH
115
PCI APP
114
MC
136
WIRELINE NETWORK
170
49
CACHE
51
CALL PROCESSOR
126
SCP PH
IP FUNC
130
TC
150
PC
154
VPs
160
161
T1
ADSI
164
SDS
T1
FAX
PSTN
58
152
SC
156
163
162
PCI DATABASE
44

FIG. 5

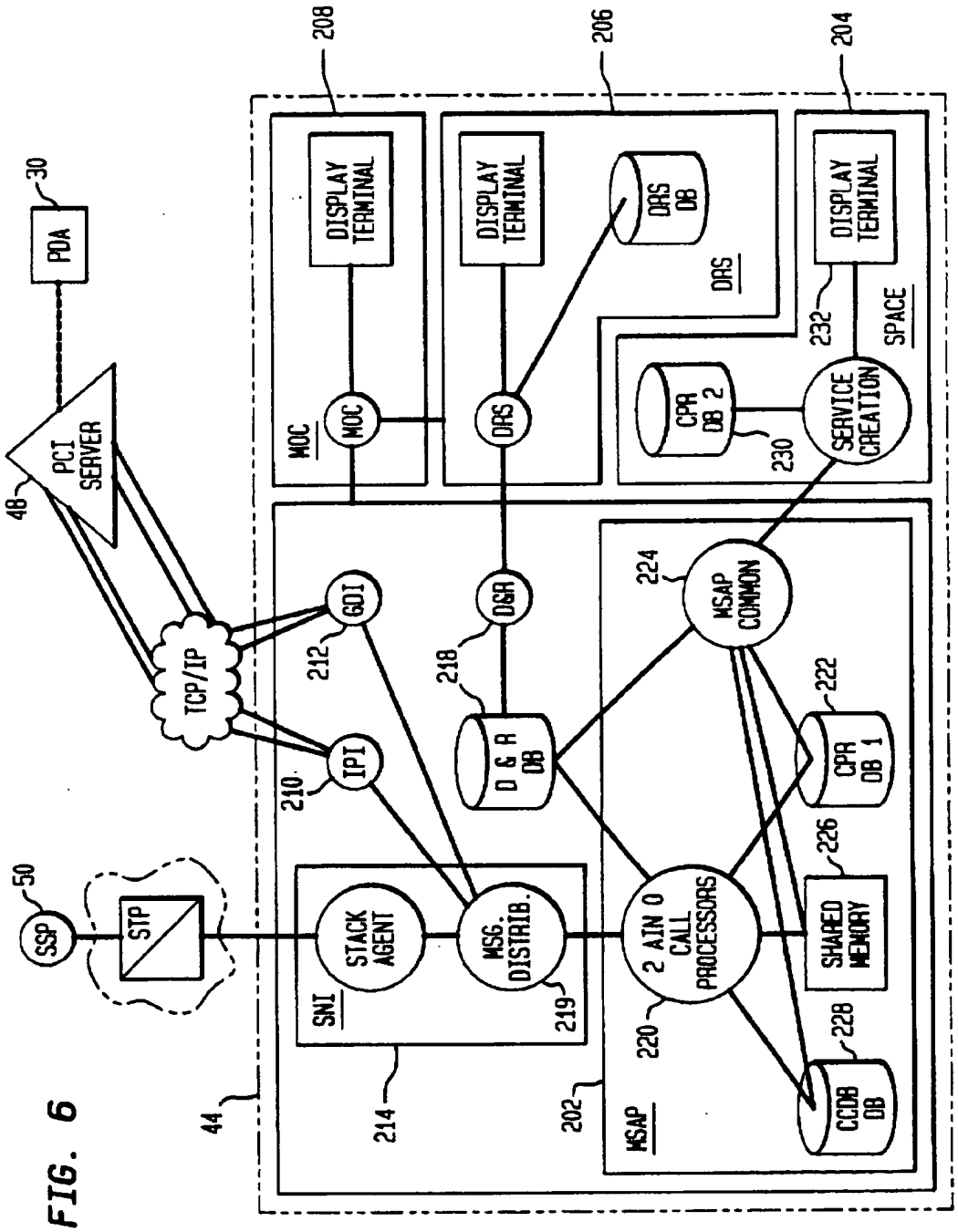

208
206
204
DISPLAY TERMINAL
DISPLAY TERMINAL
DISPLAY TERMINAL
DRS DB
DRS
MOC
MOC
DRS
SPACE
232
CPR DB 2
230
SERVICE CREATION
30
PDA
PCI SERVER
48
TCP/IP
GDI
212
IPI
210
DGR
218
D & R DB
224
MSAP COMMON
222
CPR DB 1
226
SHARED MEMORY
228
CCDB DB
220
2 AIN 0 CALL PROCESSORS
50
SSP
STP
STACK AGENT
SNI
MSG. DISTRIB.
219
214
202
MSAP
44

FIG. 6

FIG. 7

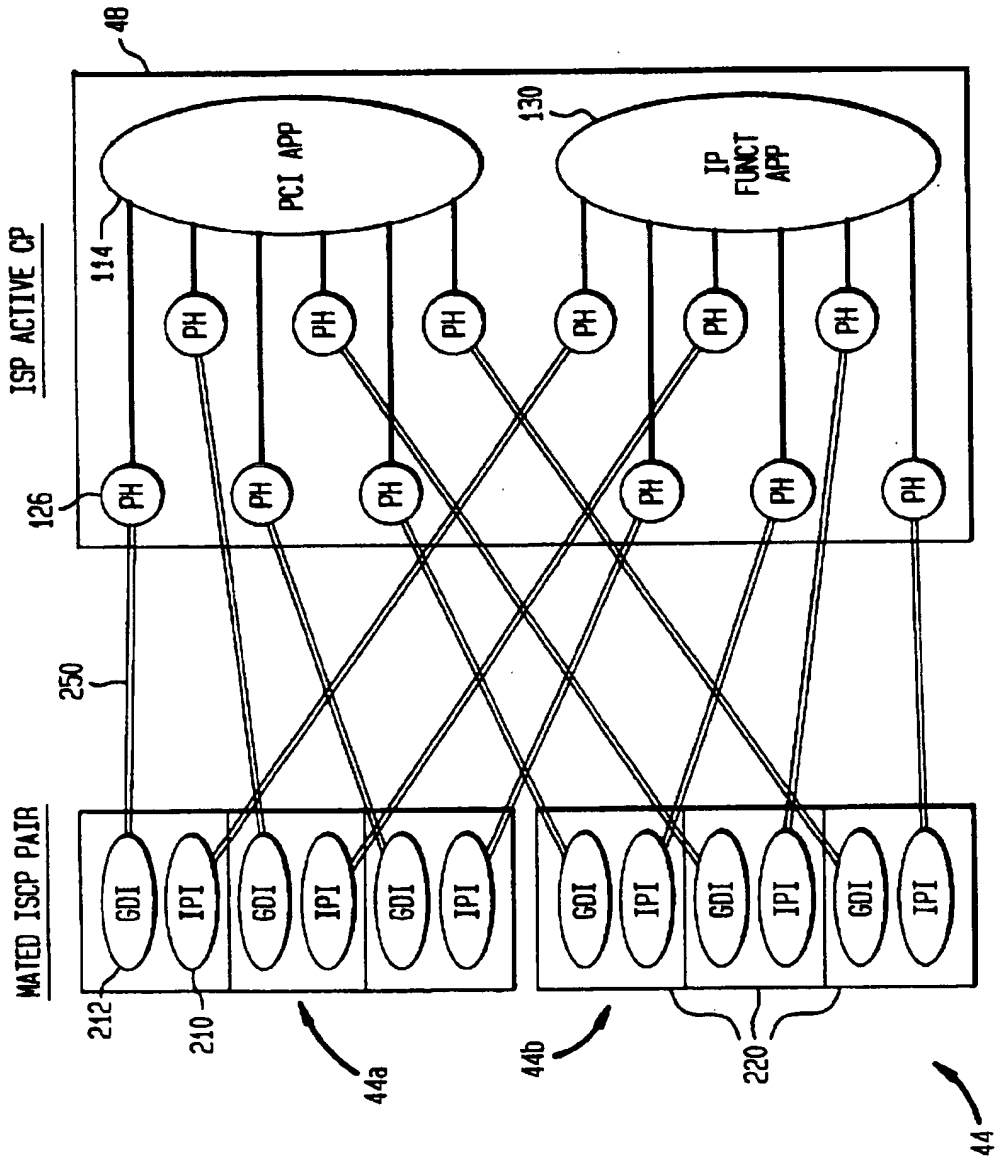

48
130
PCI APP
IP FUNCT APP
114
ISP ACTIVE CP
PH
126
250
MATED ISCP PAIR
GDI
IPI
212
210
44a
44b
220
44

FIG. 8

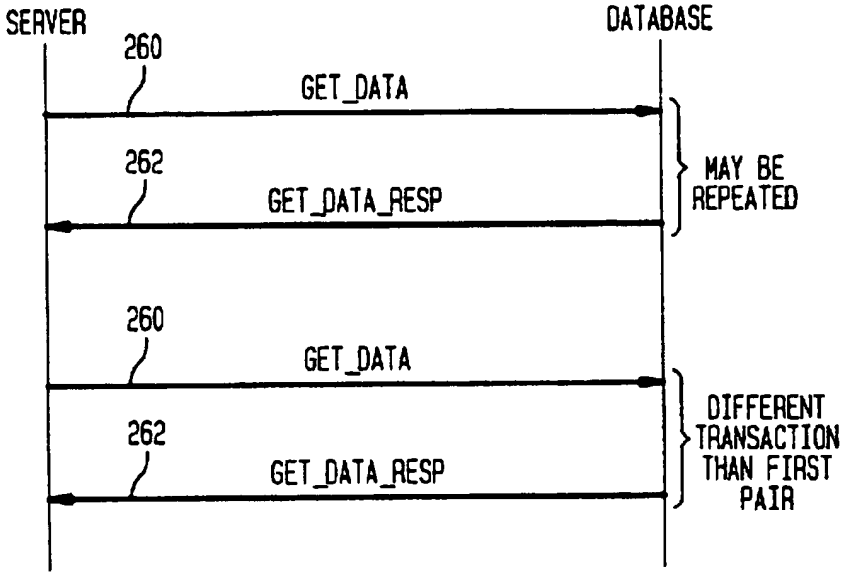

SERVER
DATABASE
260
GET_DATA
262
GET_DATA_RESP
MAY BE REPEATED
260
GET_DATA
262
GET_DATA_RESP
DIFFERENT TRANSACTION THAN FIRST PAIR

FIG. 9

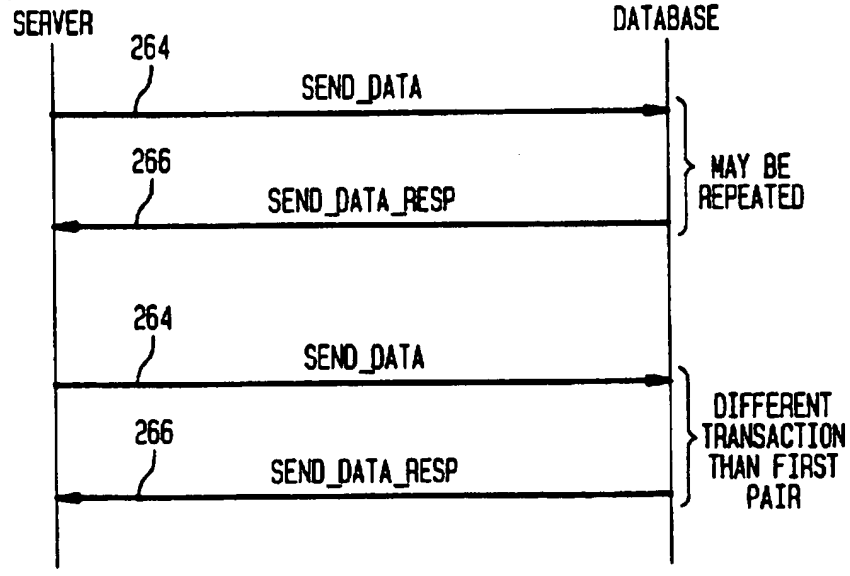

SERVER
DATABASE
264
SEND_DATA
266
SEND_DATA_RESP
MAY BE REPEATED
264
SEND_DATA
266
SEND_DATA_RESP
DIFFERENT TRANSACTION THAN FIRST PAIR

FIG. 10

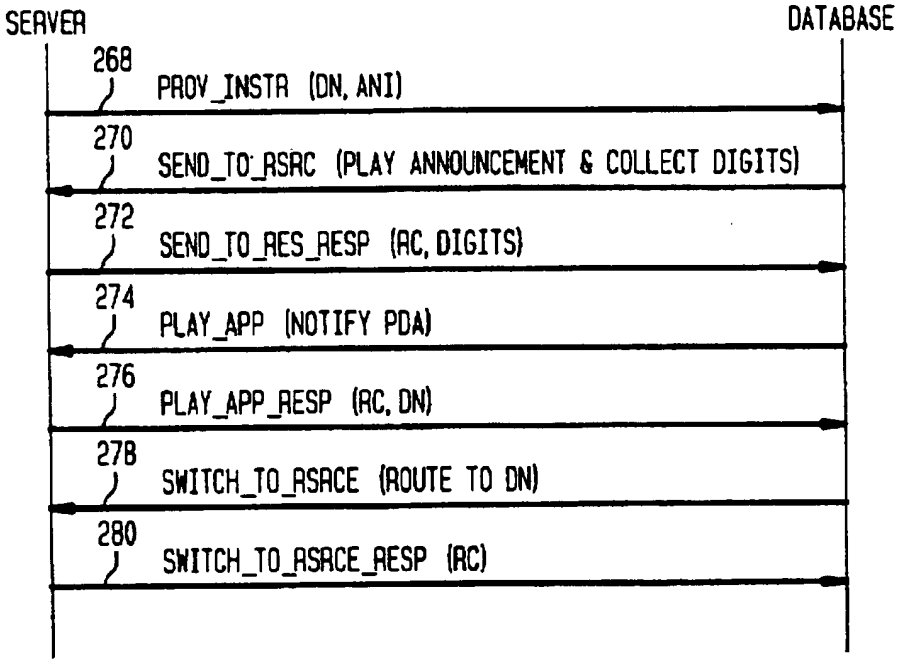

SERVER
DATABASE
268
PROV_INSTR (DN, ANI)
270
SEND_TO_RSRC (PLAY ANNOUNCEMENT & COLLECT DIGITS)
272
SEND_TO_RES_RESP (RC, DIGITS)
274
PLAY_APP (NOTIFY PDA)
276
PLAY_APP_RESP (RC, DN)
278
SWITCH_TO_RSRCE (ROUTE TO DN)
280
SWITCH_TO_RSRCE_RESP (RC)

FIG. 11

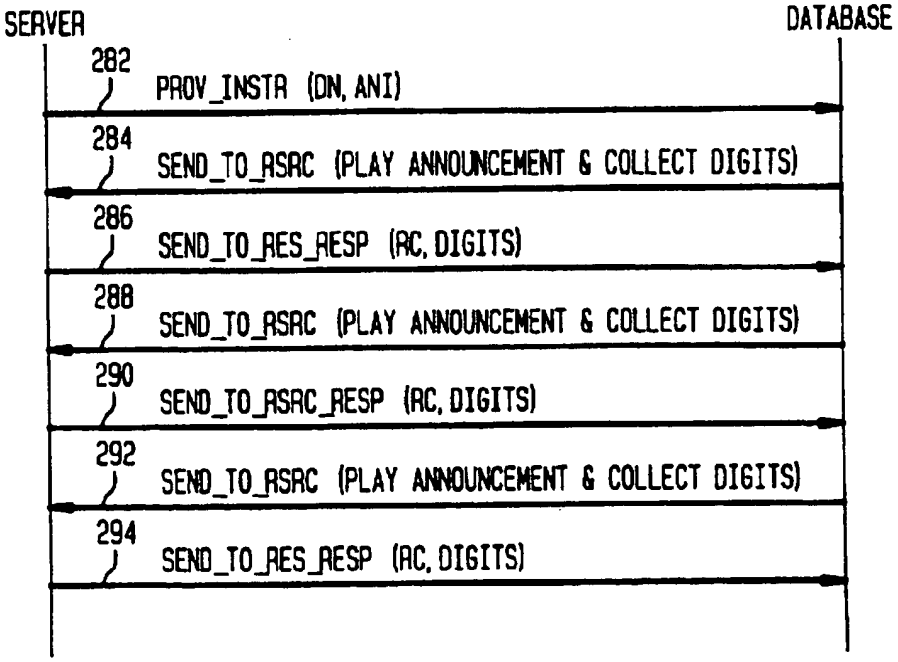

SERVER
DATABASE
282
PROV_INSTR (DN, ANI)
284
SEND_TO_RSRC (PLAY ANNOUNCEMENT & COLLECT DIGITS)
286
SEND_TO_RES_RESP (RC, DIGITS)
288
SEND_TO_RSRC (PLAY ANNOUNCEMENT & COLLECT DIGITS)
290
SEND_TO_RSRC_RESP (RC, DIGITS)
292
SEND_TO_RSRC (PLAY ANNOUNCEMENT & COLLECT DIGITS)
294
SEND_TO_RES_RESP (RC, DIGITS)

FIG. 12

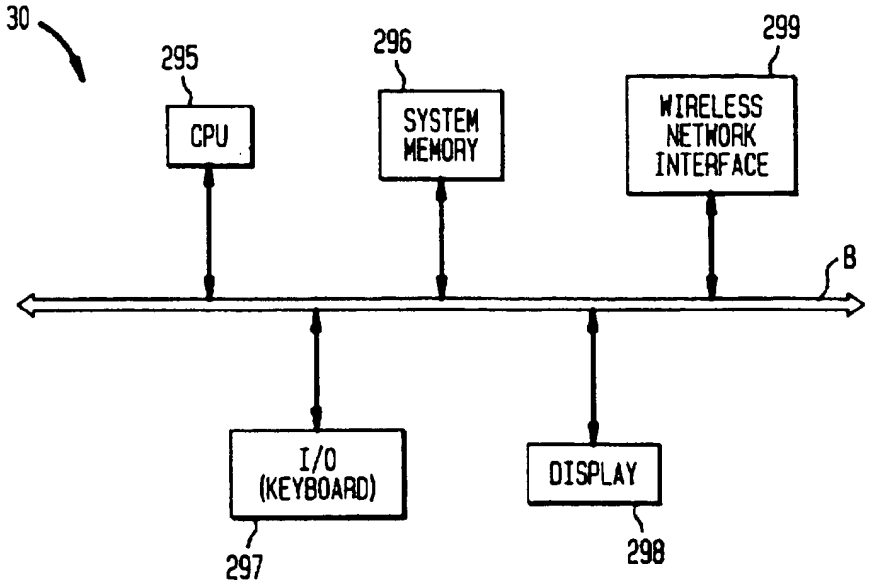


FIG. 13

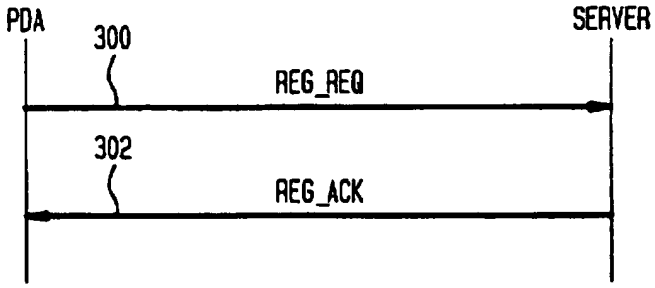


FIG. 14

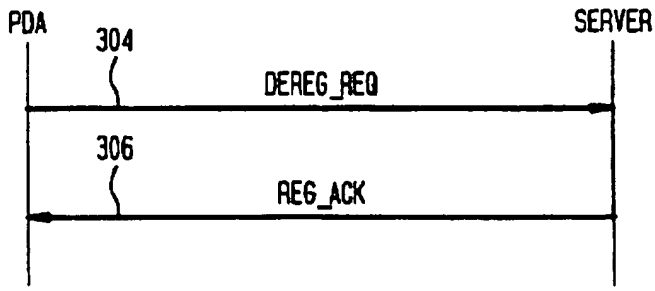


FIG. 15

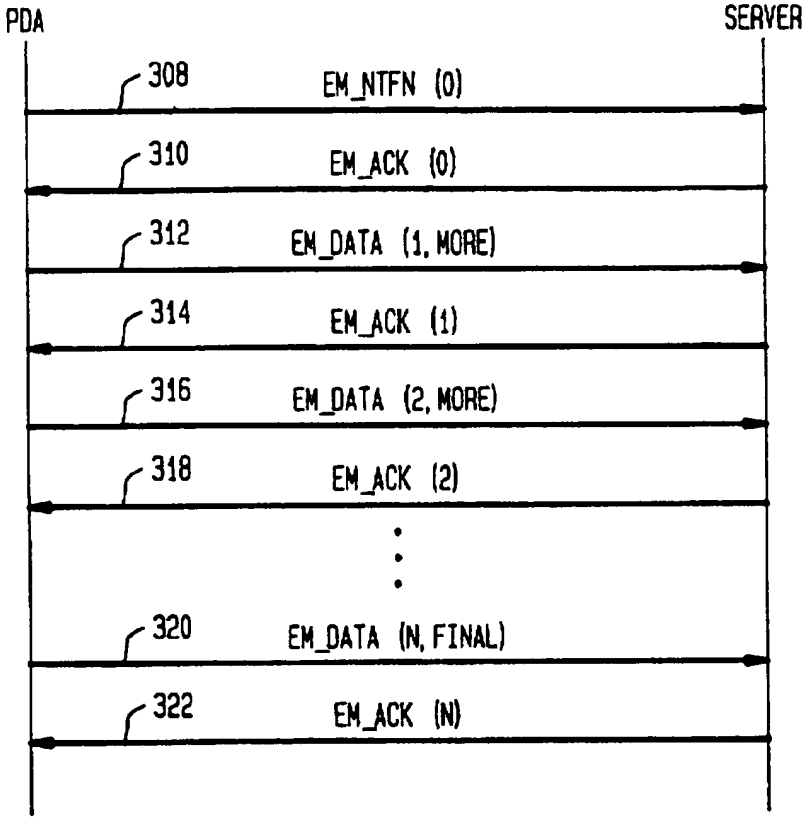


FIG. 16A

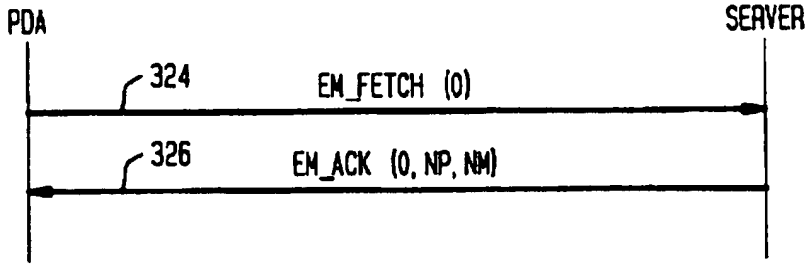


FIG. 16B

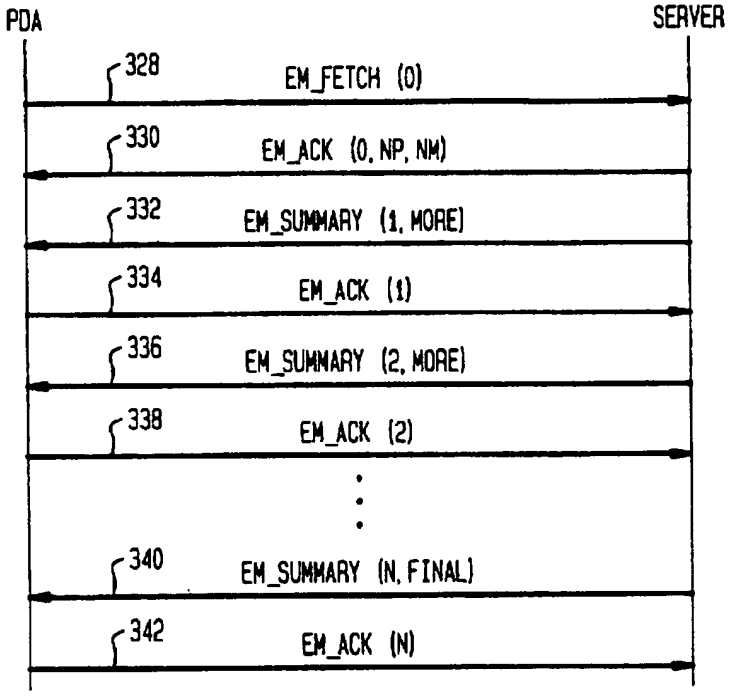


FIG. 17

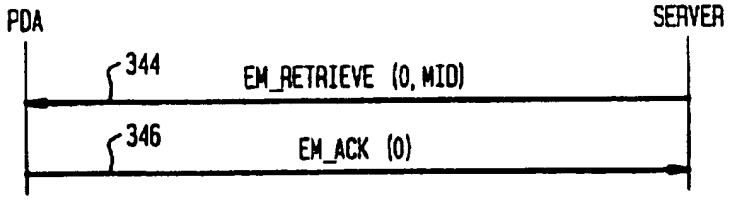


FIG. 18

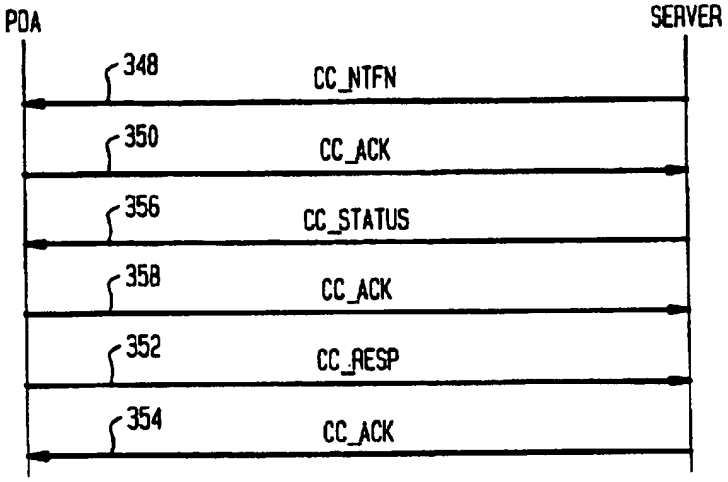


FIG. 19

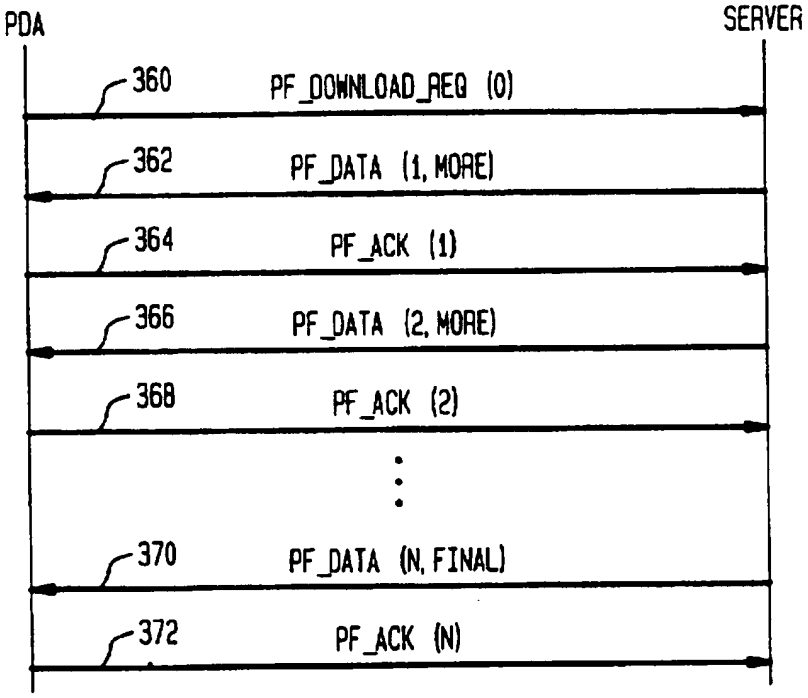


FIG. 20A

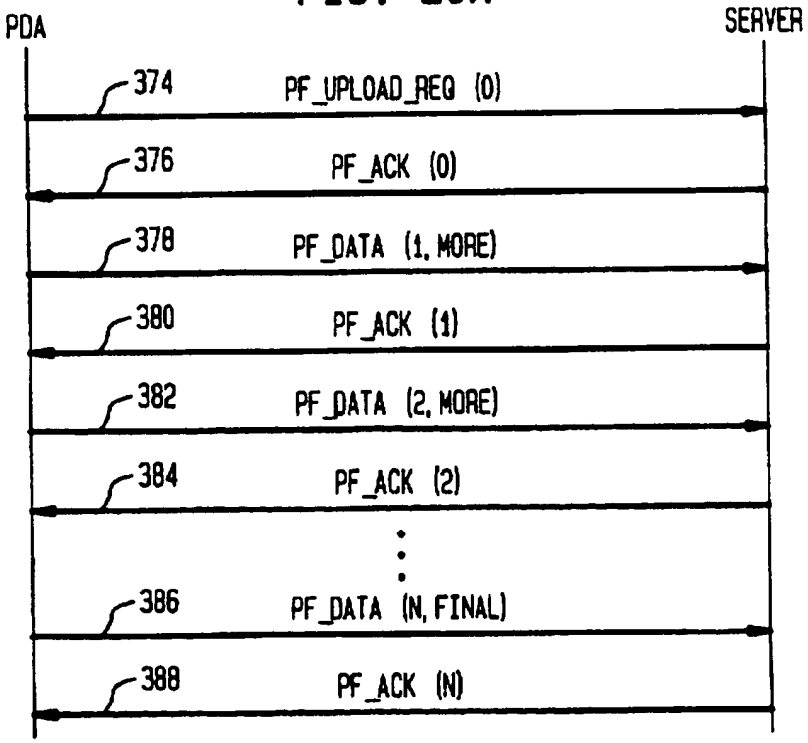
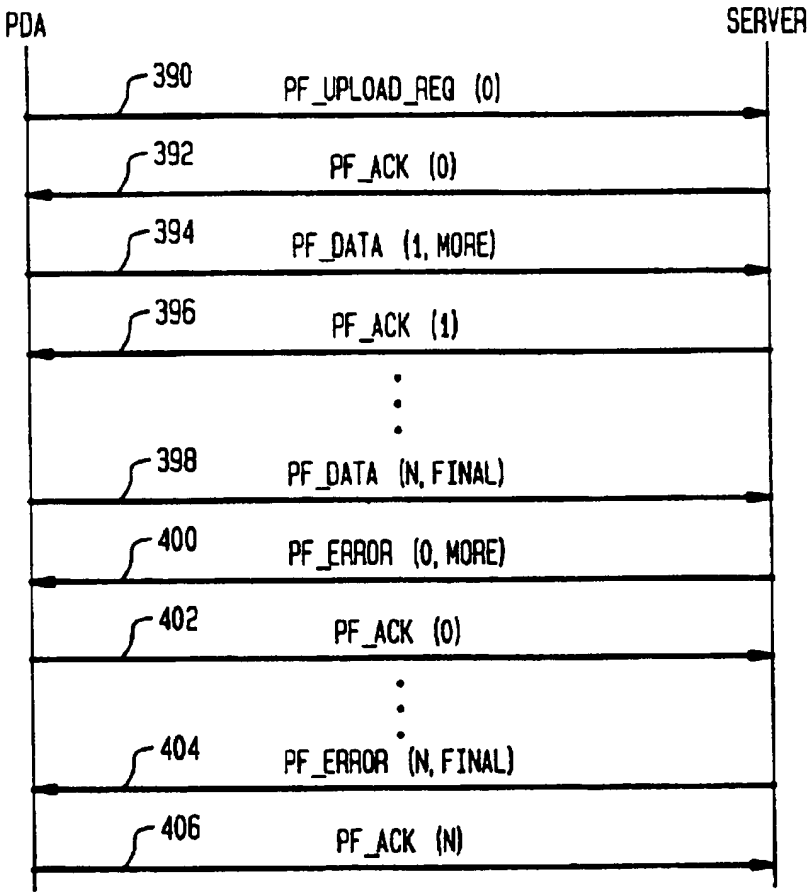


FIG. 20B


PDA
SERVER
390
PF_UPLOAD_REQ (0)
392
PF_ACK (0)
394
PF_DATA (1, MORE)
396
PF_ACK (1)
398
PF_DATA (N, FINAL)
400
PF_ERROR (0, MORE)
402
PF_ACK (0)
404
PF_ERROR (N, FINAL)
406
PF_ACK (N)

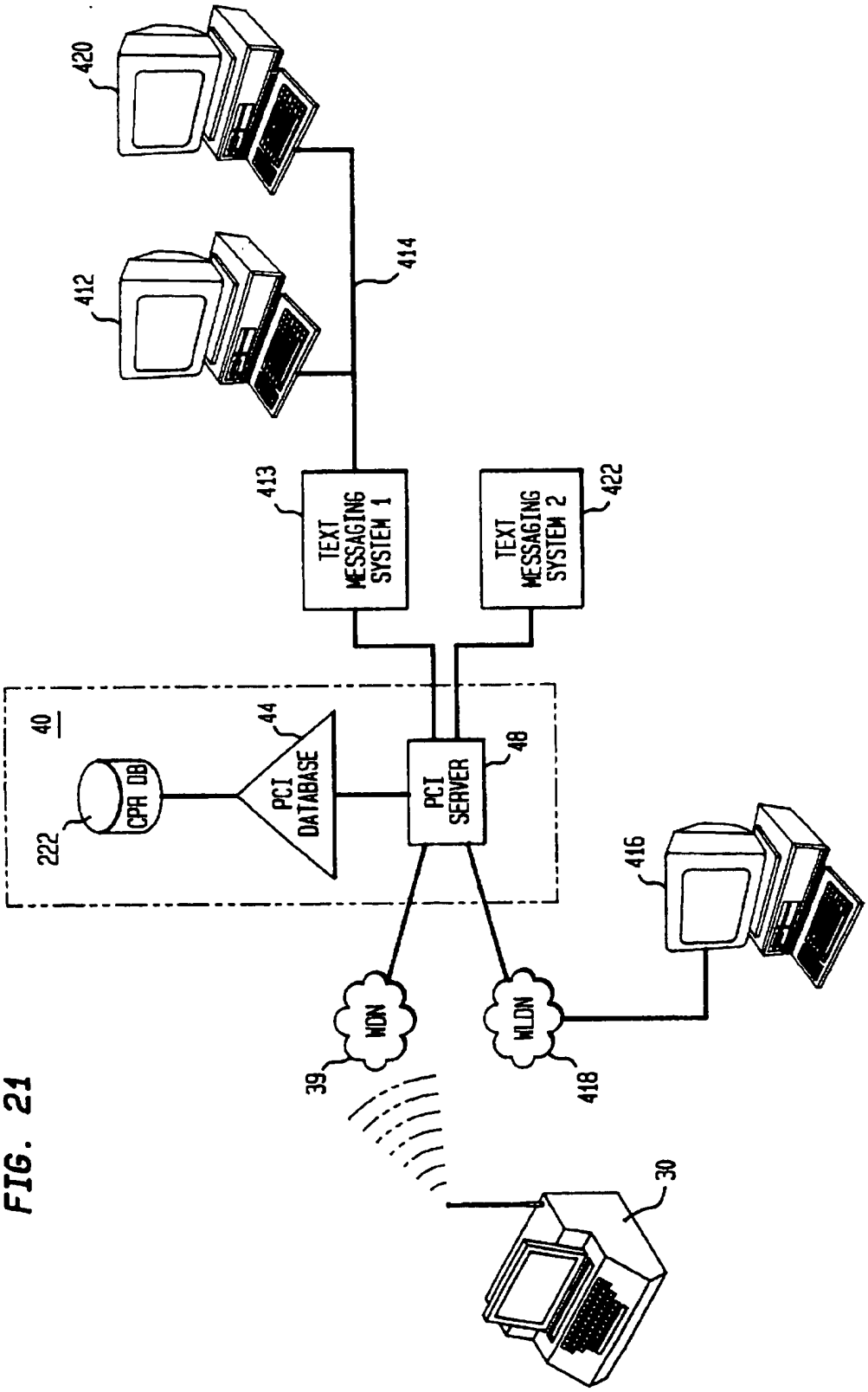

420
412
414
413
TEXT MESSAGING SYSTEM 1
422
TEXT MESSAGING SYSTEM 2
40
44
CPR DB
222
PCI DATABASE
PCI SERVER
48
416
WDN
39
WLDN
418
30

FIG. 21

FIG. 22

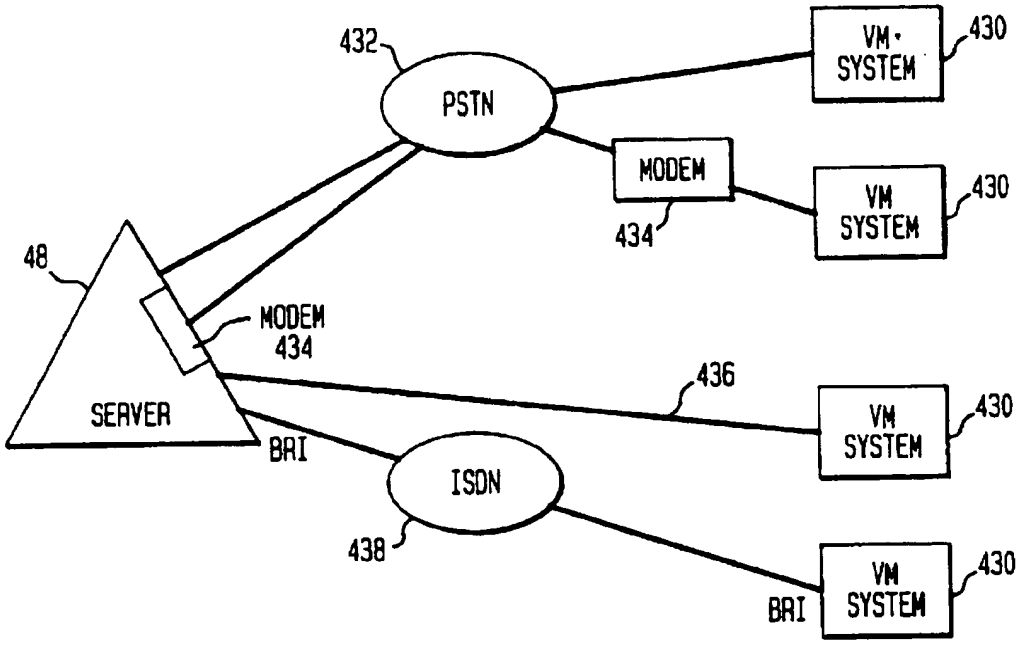
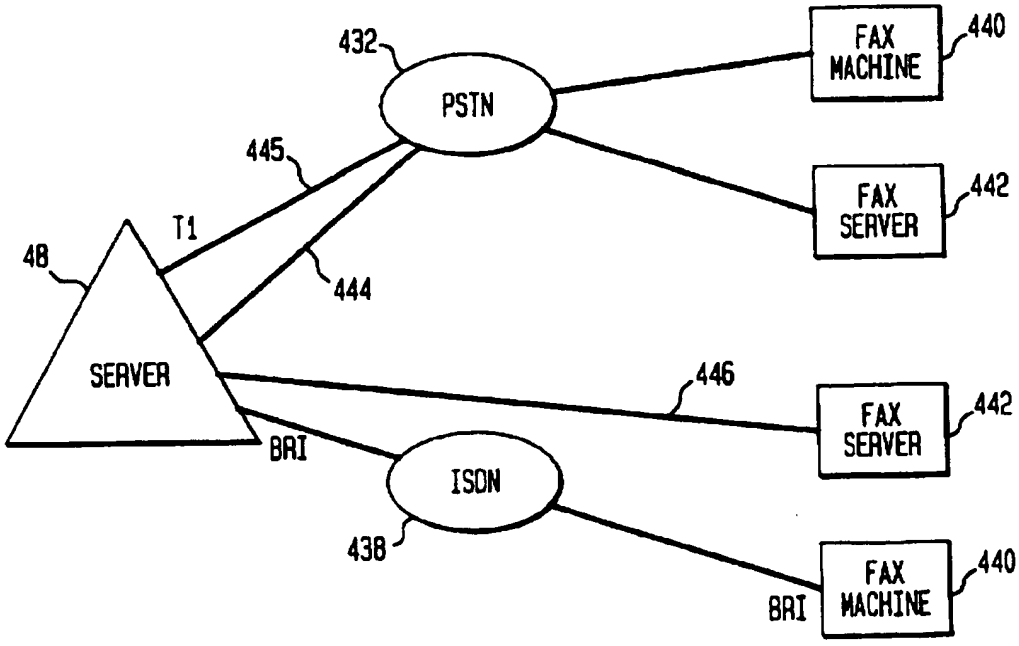

432
PSTN
VM SYSTEM
430
MODEM
434
VM SYSTEM
430
48
MODEM
434
SERVER
436
VM SYSTEM
430
BRI
ISDN
438
VM SYSTEM
430
BRI

FIG. 23


432
PSTN
FAX MACHINE
440
445
FAX SERVER
442
T1
48
444
SERVER
446
FAX SERVER
442
BRI
ISDN
438
FAX MACHINE
440
BRI

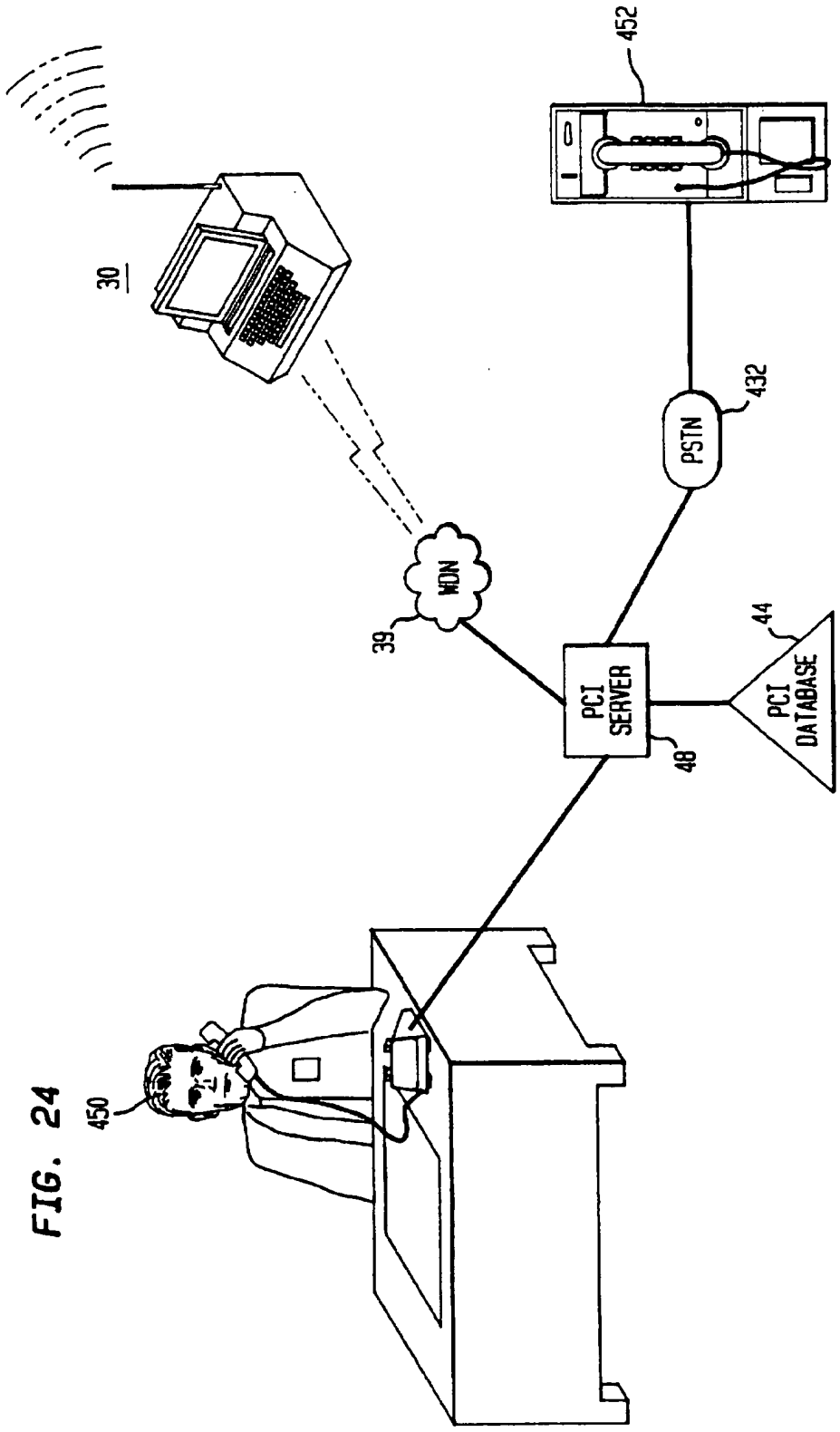
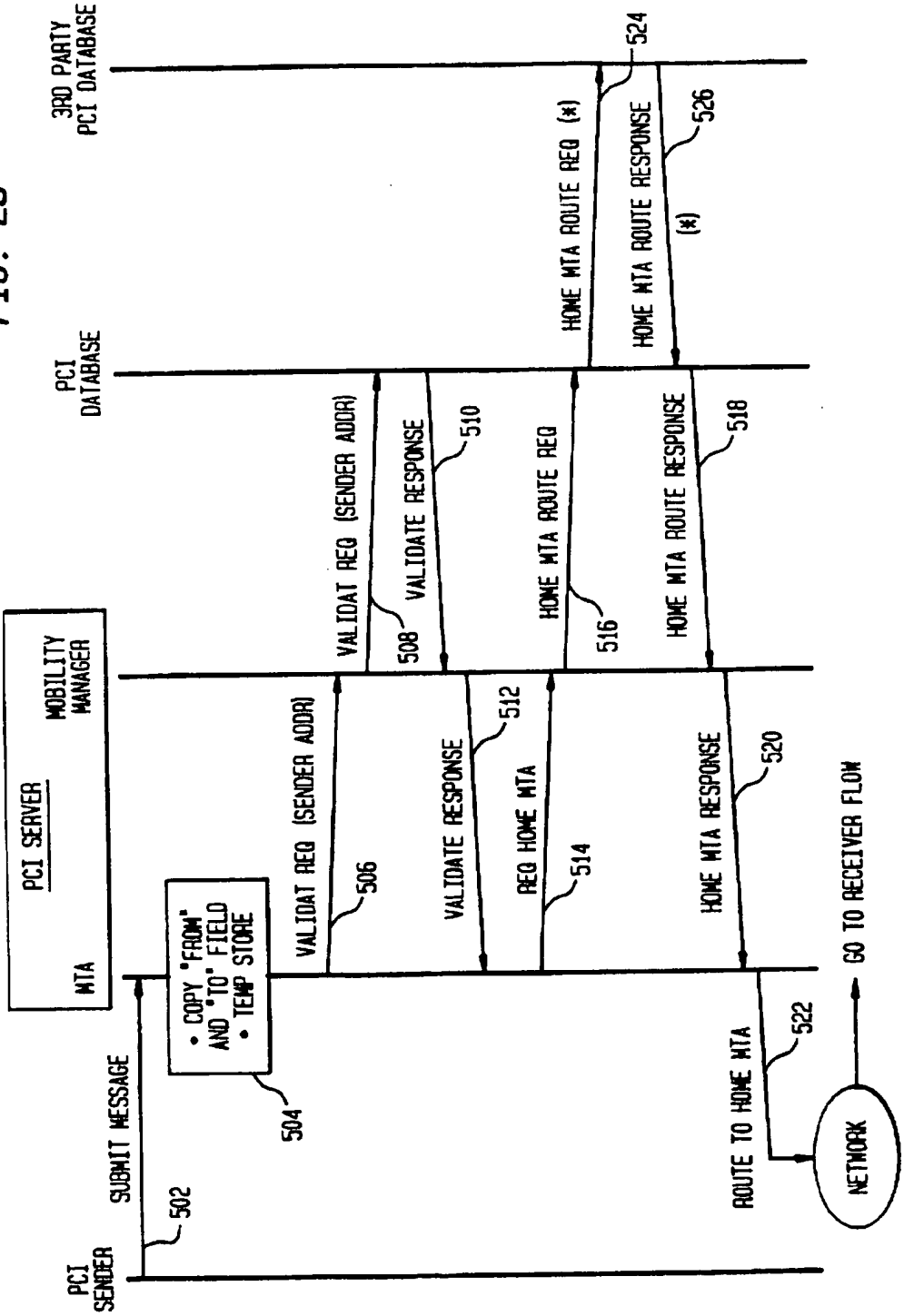


FIG. 24

FIG. 25


3RD PARTY PCI DATABASE
PCI DATABASE
PCI SERVER
MOBILITY MANAGER
MTA
PCI SENDER
SUBMIT MESSAGE
502
• COPY 'FROM' AND 'TO' FIELD
• TEMP STORE
504
VALIDAT REQ (SENDER ADDR)
506
VALIDATE RESPONSE
508
VALIDATE RESPONSE
510
REQ HOME MTA
512
HOME MTA ROUTE REQ
514
HOME MTA RESPONSE
516
HOME MTA ROUTE RESPONSE
518
HOME MTA RESPONSE
520
ROUTE TO HOME MTA
522
HOME MTA ROUTE REQ (*)
524
HOME MTA ROUTE RESPONSE (*)
526
NETWORK
GO TO RECEIVER FLOW

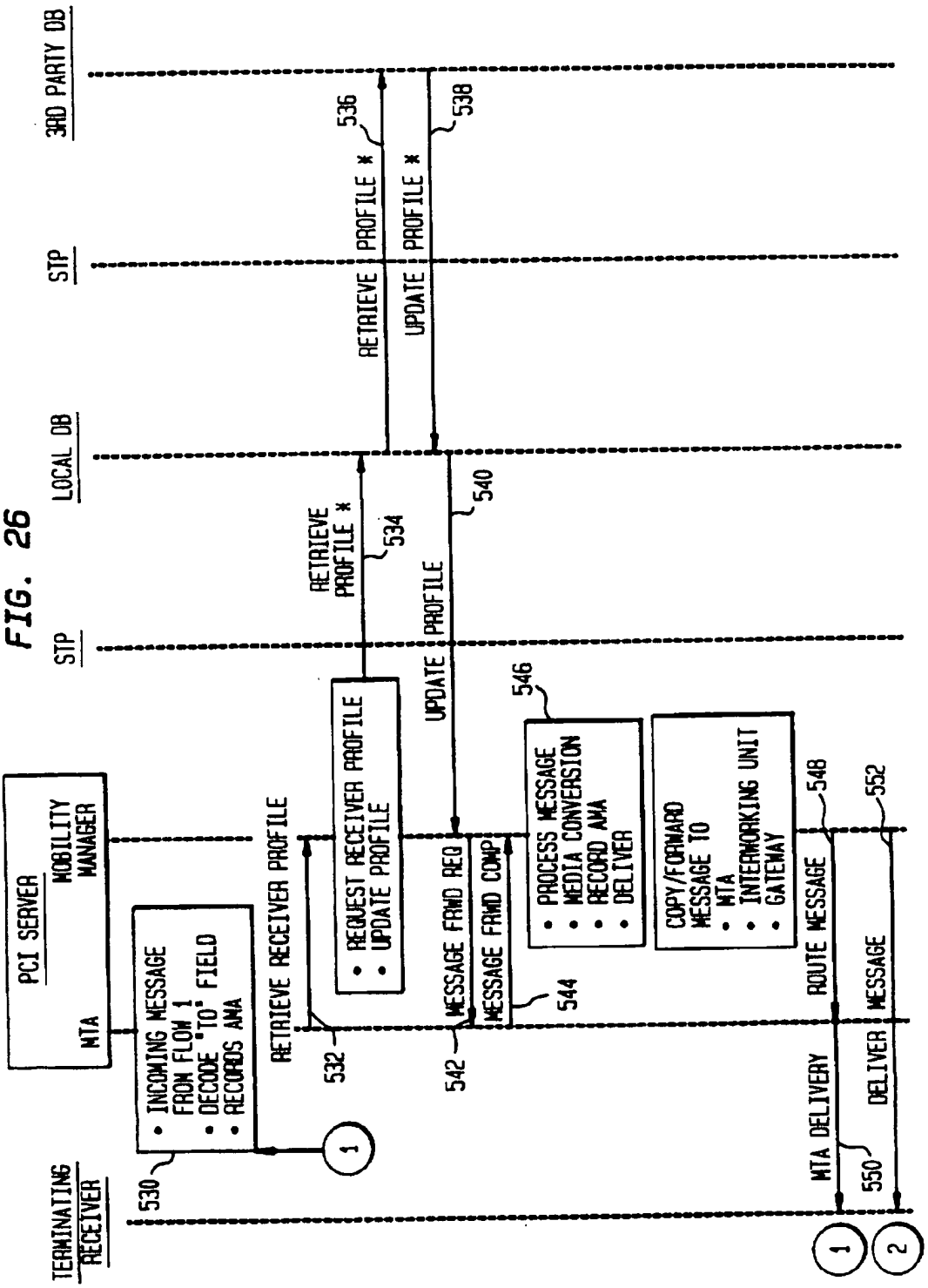

3RD PARTY DB
STP
LOCAL DB
STP
TERMINATING RECEIVER
PCI SERVER
MOBILITY MANAGER
MTA
• INCOMING MESSAGE FROM FLOW 1
• DECODE 'TO' FIELD
• RECORDS ANA
RETRIEVE RECEIVER PROFILE
• REQUEST RECEIVER PROFILE
• UPDATE PROFILE
RETRIEVE PROFILE *
UPDATE PROFILE
MESSAGE FRWD REQ
MESSAGE FRWD COMP
• PROCESS MESSAGE
• MEDIA CONVERSION
• RECORD ANA
• DELIVER
COPY/FORWARD MESSAGE TO
• MTA
• INTERWORKING UNIT
• GATEWAY
ROUTE MESSAGE
MTA DELIVERY
DELIVER MESSAGE
RETRIEVE PROFILE *
UPDATE PROFILE *
530
532
534
536
538
540
542
544
546
548
550
552
1
2

FIG. 26

FIG. 27

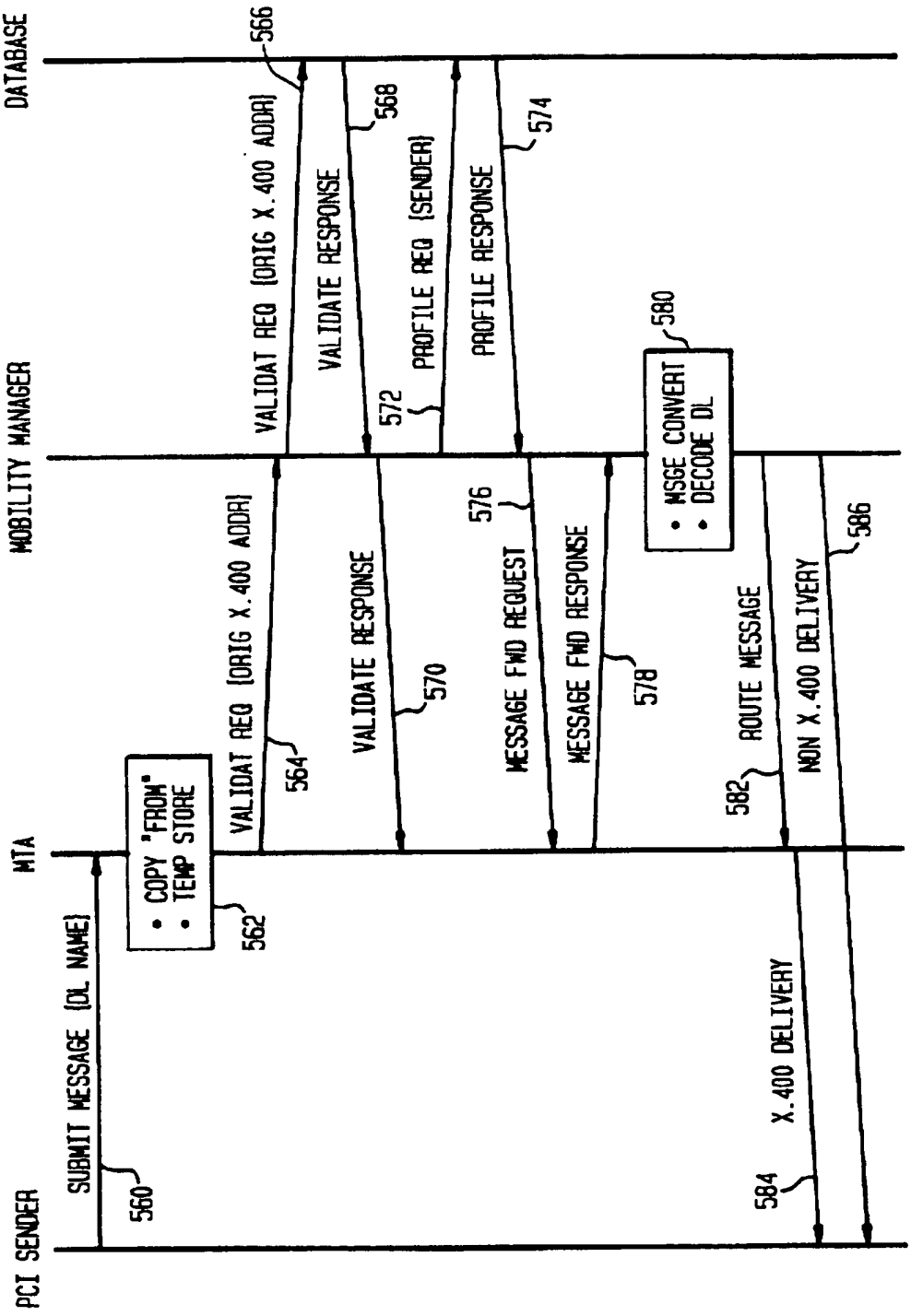

DATABASE
MOBILITY MANAGER
MTA
PCI SENDER
SUBMIT MESSAGE (DL NAME)
560
• COPY "FROM"
• TEMP STORE
562
VALIDAT REQ (ORIG X.400 ADDR)
564
VALIDAT REQ (ORIG X.400 ADDR)
566
VALIDATE RESPONSE
568
VALIDATE RESPONSE
570
PROFILE REQ (SENDER)
572
PROFILE RESPONSE
574
MESSAGE FWD REQUEST
576
MESSAGE FWD RESPONSE
578
• MSGE CONVERT
• DECODE DL
580
ROUTE MESSAGE
582
X.400 DELIVERY
584
NON X.400 DELIVERY
586

FIG. 28

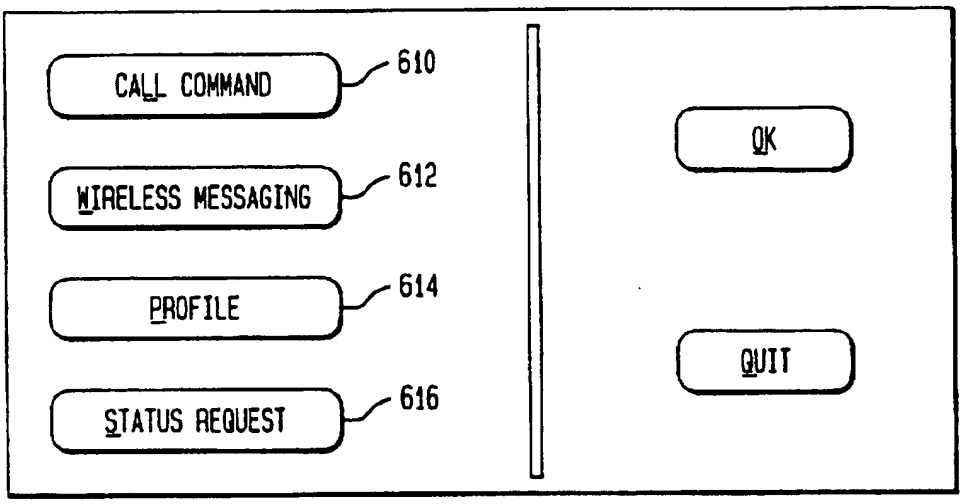


FIG. 29

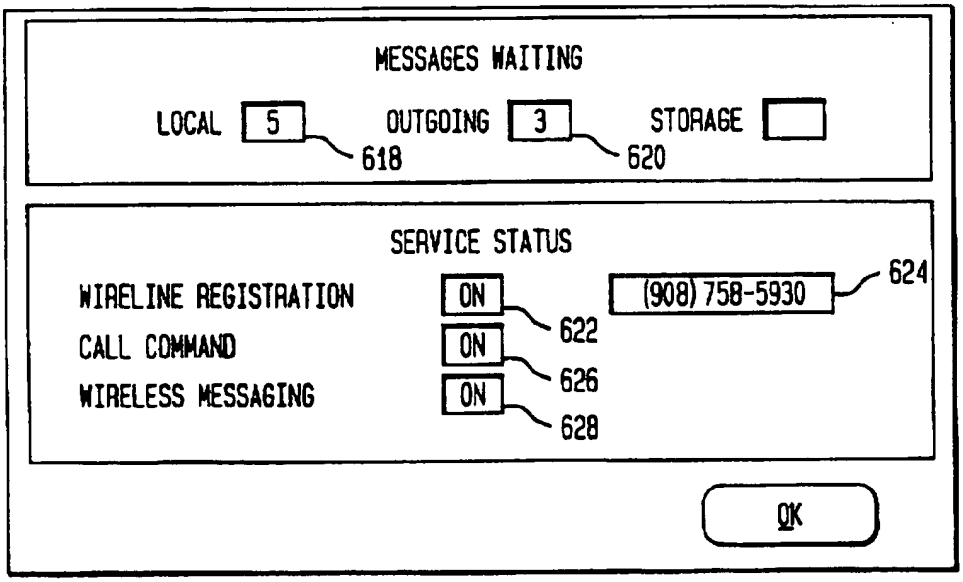


FIG. 30

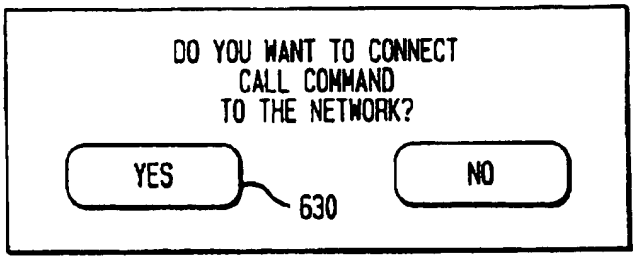


FIG. 31

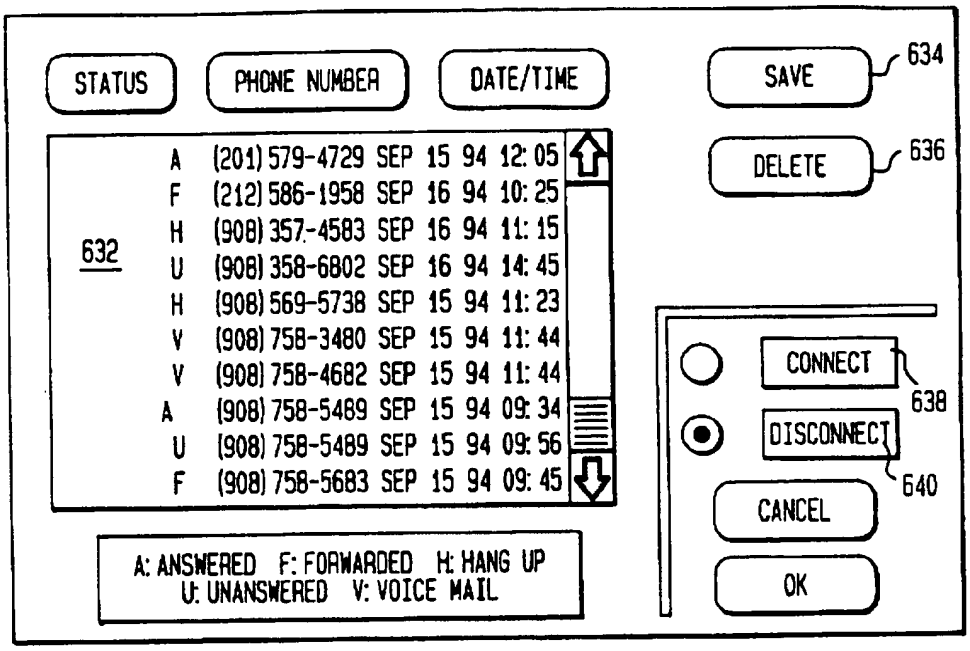


FIG. 33

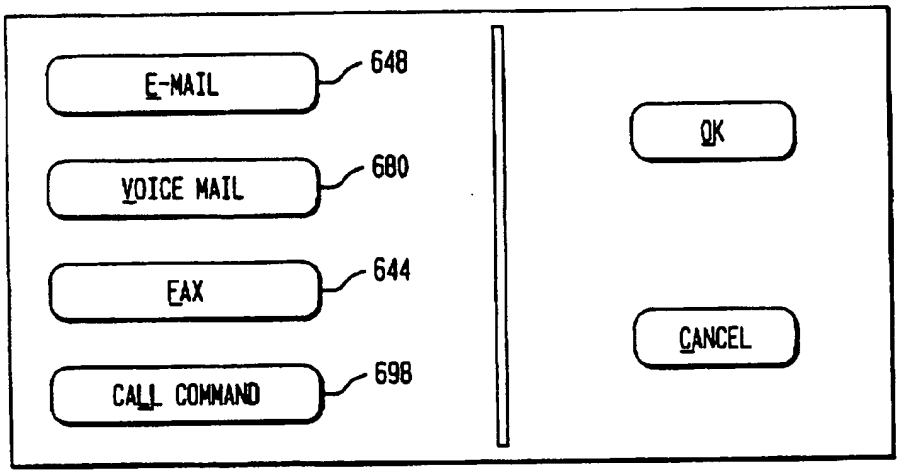


FIG. 32

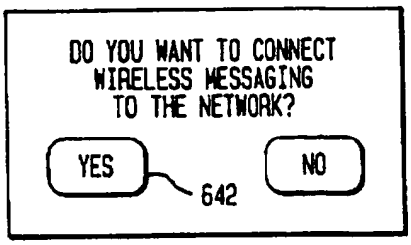


FIG. 34

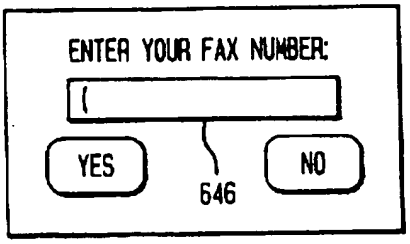


FIG. 35

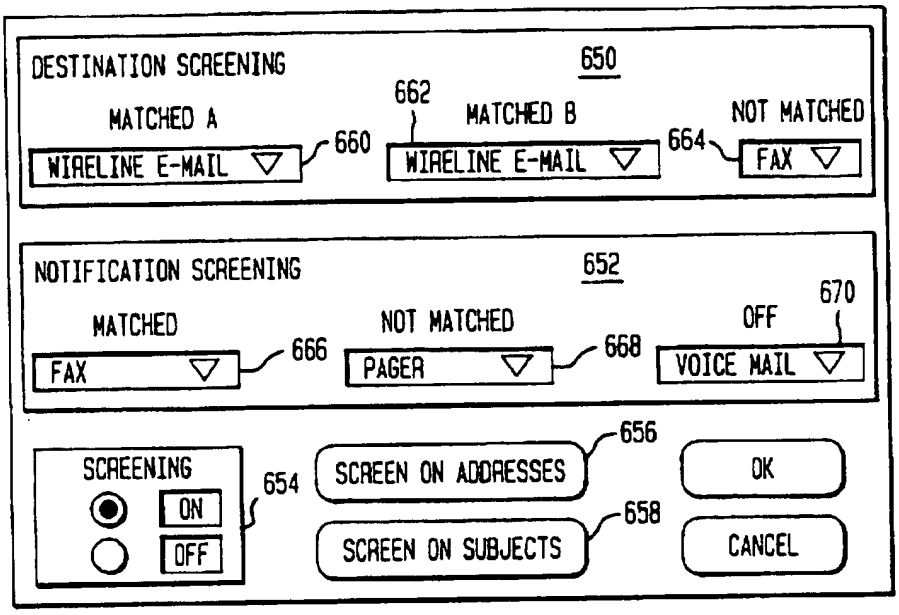


FIG. 36

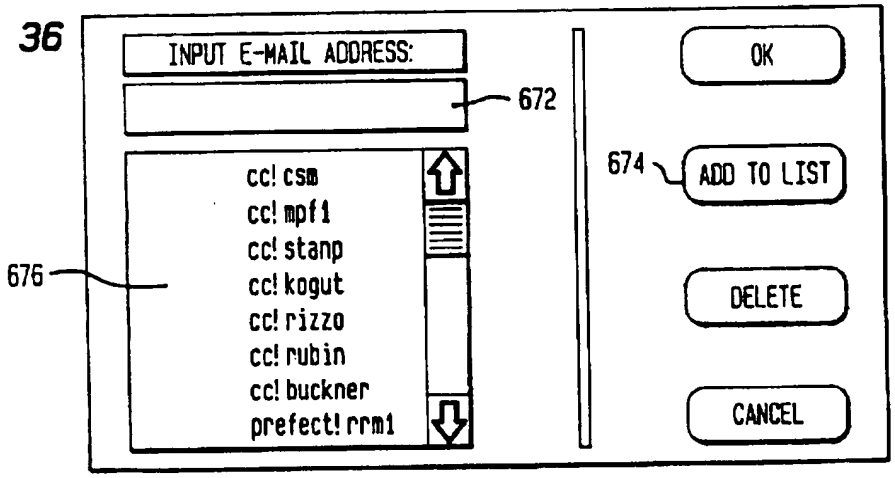


FIG. 37

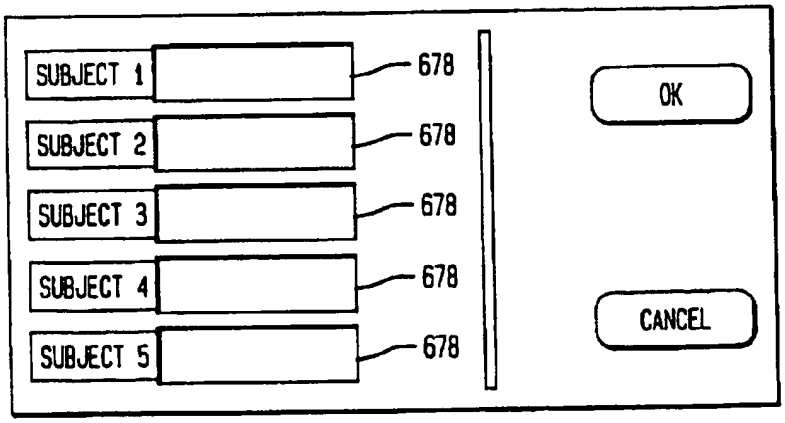


FIG. 38

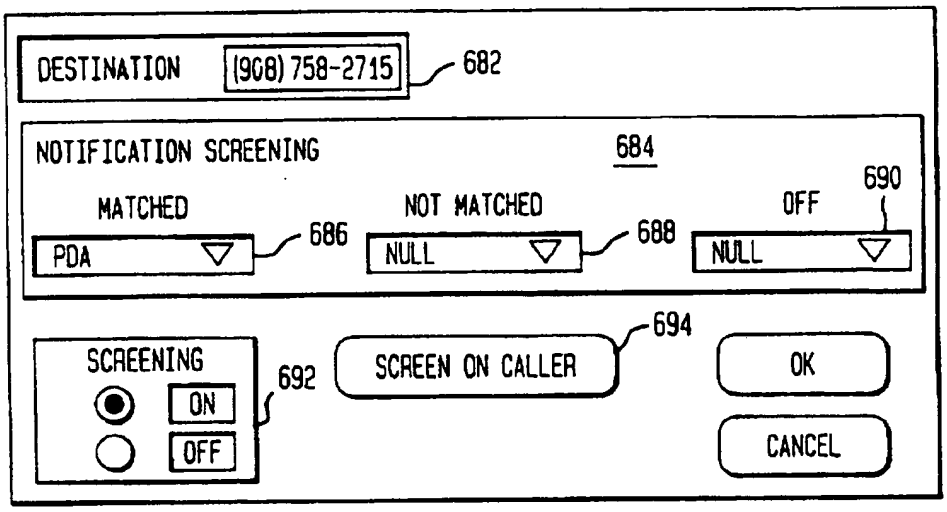


FIG. 39

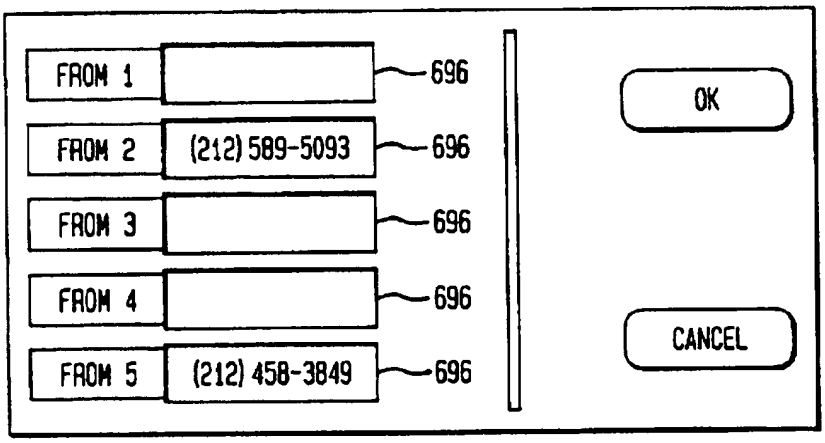


FIG. 40

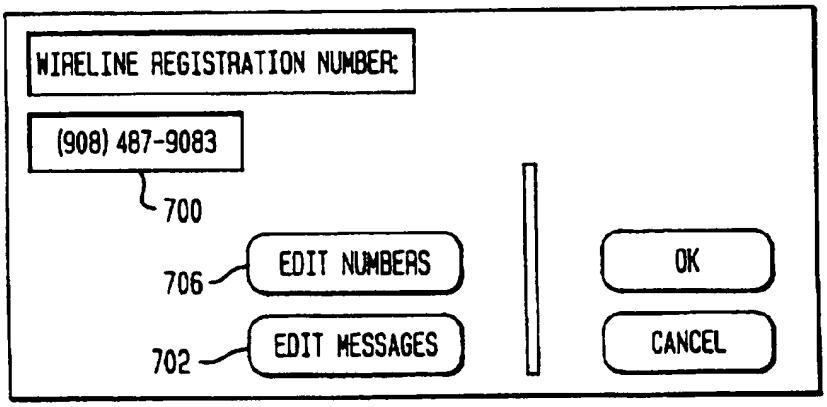


FIG. 41

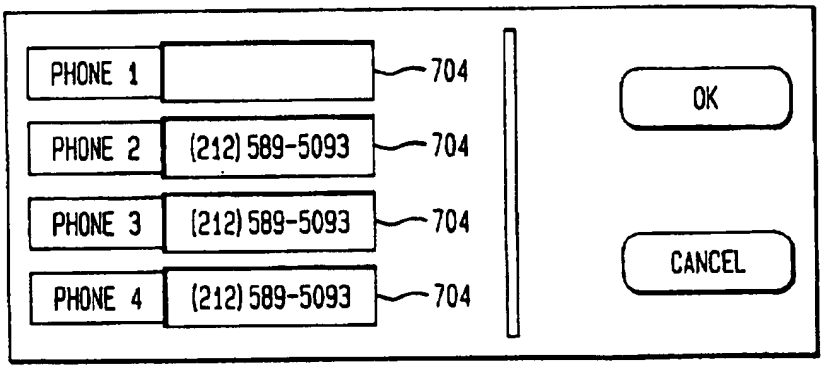


FIG. 42

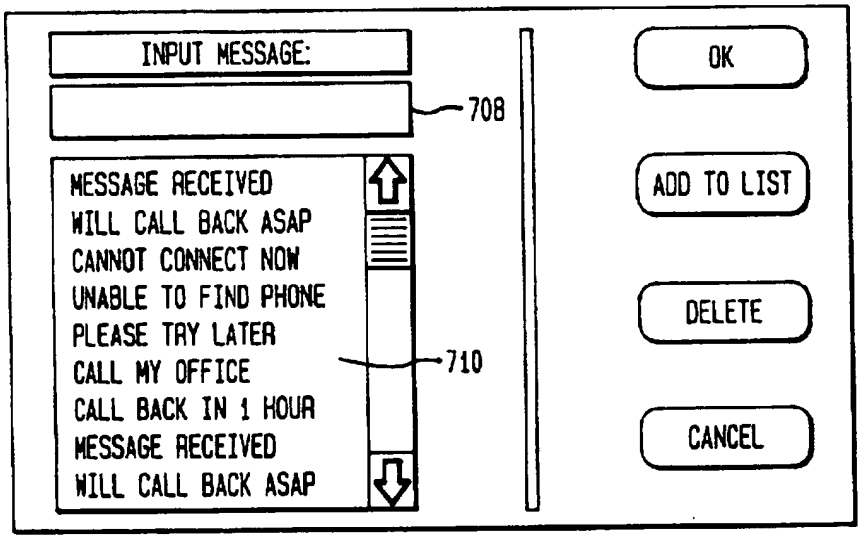


FIG. 43

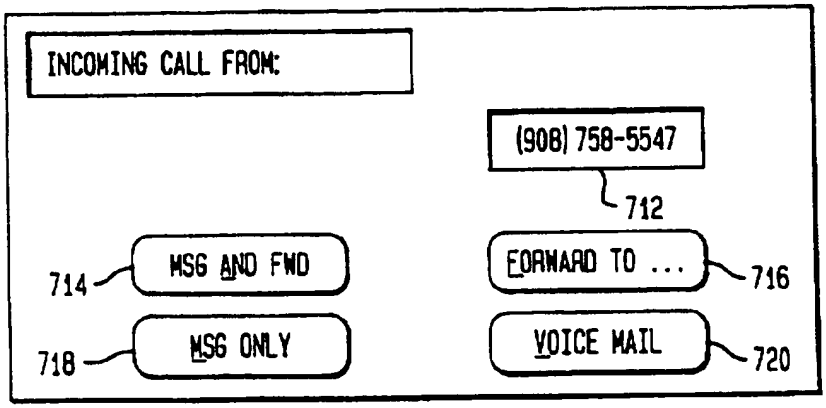


FIG. 44

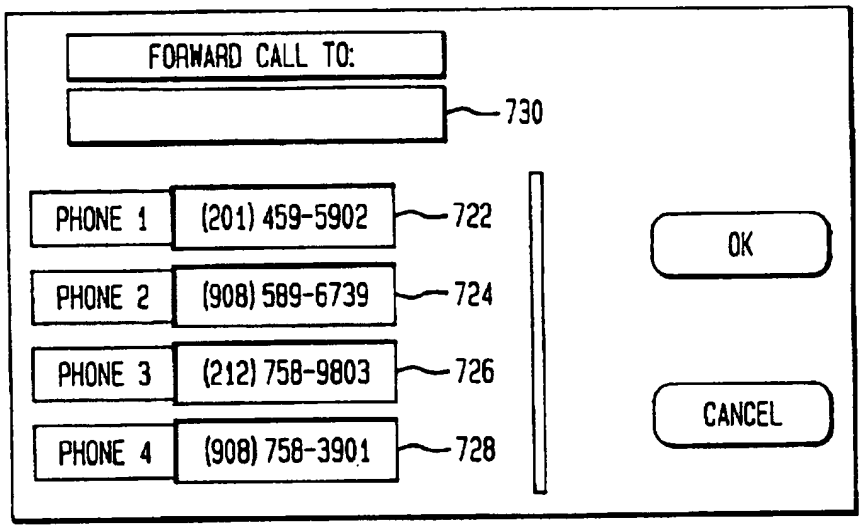
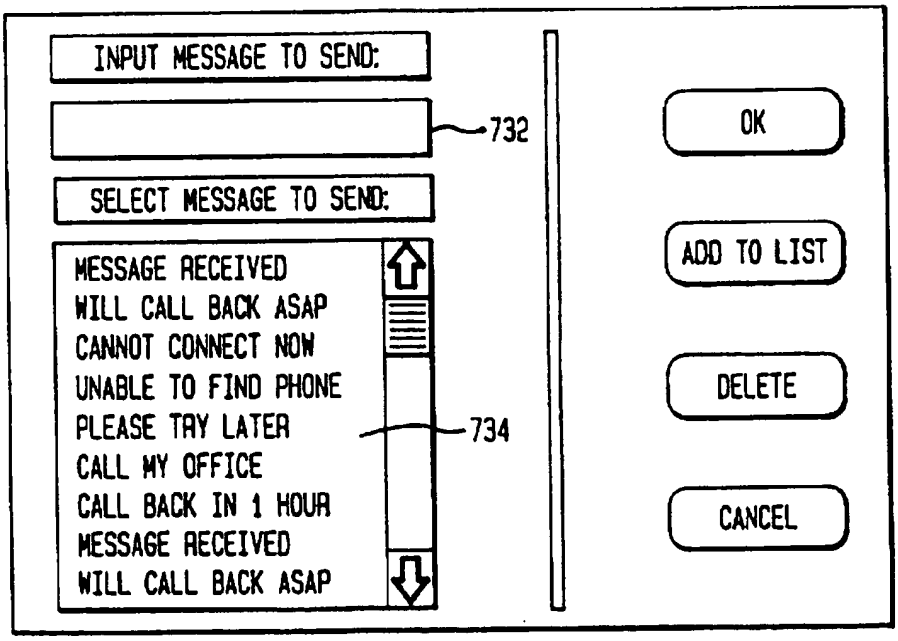

FORWARD CALL TO:
730
PHONE 1
(201) 459-5902
722
PHONE 2
(908) 589-6739
724
PHONE 3
(212) 758-9803
726
PHONE 4
(908) 758-3901
728
OK
CANCEL

FIG. 45


INPUT MESSAGE TO SEND:
732
SELECT MESSAGE TO SEND:
MESSAGE RECEIVED
WILL CALL BACK ASAP
CANNOT CONNECT NOW
UNABLE TO FIND PHONE
PLEASE TRY LATER
CALL MY OFFICE
CALL BACK IN 1 HOUR
MESSAGE RECEIVED
WILL CALL BACK ASAP
734
OK
ADD TO LIST
DELETE
CANCEL

PERSONAL COMMUNICATIONS INTERNETWORKING

FIELD OF THE INVENTION

The present invention is directed to an internetwork for personal communications and, more particularly, to a network which allows a mobile communications subscriber to remotely control personal communications delivery options.

BACKGROUND OF THE INVENTION

The use of messaging as a means of day-to-day communications continues to grow and evolve, particularly in a business context. Messaging includes electronic mail (e-mail), facsimile transmissions (fax), paging, voice mail, and telephone communications. The introduction of the cellular phone and other wireless communications facilitated the advent of the "mobile office". The mobile office allows an employee, for example, to work away from the office on a portable computer and be in constant touch with the office via a cellular phone.

The messaging options described above are available to businesses of all sizes, as well as individual users, from a variety of service providers. Many offices have some or all of the messaging options described above. The office may have certain messaging equipment (referred to as "consumer premises equipment" or "CPE") connected to one or more wireline networks. That is, the office may have telephones, fax servers, and voice mail systems connected to phone lines, and computers having modems for e-mail connected to packet networks which are connected via phone lines. The mobile employee may have certain wireless messaging equipment, such as a pager, a cellular telephone, or a personal digital assistant ("PDA"), which is typically a notebook computer connected to a wireless communication network.

One important goal of personal communication services is to allow users to communicate from anywhere to anywhere at any time. Such personal communication services generally involve multiple service providers including local and long distance telephone companies and cellular telephone companies. An example of a personal communication service is as follows:

A personal communication service provider (e.g., a cellular telephone company) enables traveling users to rent a wireless portable phone from a rental phone company (e.g., from an airline or car rental company). Using the rental phone, the user is provided with basic mobile phone service from the personal communication service provider. In addition, the user would like the following features:

1) The user wants calls directed to his/her office or home to be automatically forwarded to the rental portable phone, without informing anyone that he/she is traveling.

2) To avoid unimportant incoming calls (and corresponding incoming call charges), the user would like to restrict the number of people who can call the rented portable phone.

3) It is important to the user that the rental phone features be activated instantly, so that calls can be made immediately upon the user's arrival at the visiting location.

This kind of personal communication service involves a plurality of service providers. These providers are (a) the local telephone company at the home location, (b) a long distance telephone company, (c) the local telephone company at the visiting location, and (d) the personal communication service provider (i.e., the cellular telephone company) at the visiting location. All of these are referred to herein as "service providers".

To enable this kind of personal communication service, involving multiple service providers, interoperability problems among the different service providers must be resolved. The interoperability problems can be divided into two categories: (a) location tracking and (b) service management.

The interoperability problem for location tracking has been addressed by adopting signaling protocols used by the mobile phone industry. Location tracking functions are implemented using two location registers. One of the registers, maintained by the local telephone company of the user's home location, is called the Home Location Register (HLR). The other register, maintained by the local telephone company of the visiting location, is called the Visiting Location Register (VLR). The HLR stores customer profile data and the location of the VLR of the user. The customer profile data contains important information such as the user's name, address, preferred long distance carrier, service features (e.g., call forwarding and call restriction), billing, and other administrative related information. When the user travels to a new visiting location, a new VLR is created in the new location. A part of the profile data stored in the HLR is transmitted and loaded into the VLR such that the service provider at the visiting location can implement service features for the visiting user. When the user travels to a new visiting location the location of the VLR stored in the HLR is changed to the new VLR location, and the VLR in the previously visited location is deleted. The process of creating a new VLR, loading profile data to the VLR, and updating the visiting location of a user in the HLR is called "automatic roamer registration".

The interoperability problem for service management is much more complex than that for location tracking. Service management refers to a collection of functions required to enable a personal communication service user to subscribe to, modify, and activate service features anywhere and at any time. Examples of service management functions include phone number administration, customer profile data management, service activation, and security administration. The phone number administration function is important for maintaining the uniqueness of phone numbers. The customer profile data management function provides customer profile databases and user interfaces for creating, modifying, or transferring such databases. The service activation function extracts part of the data specifying service features from the profile data and loads this data into physical communication systems that process calls. The service activation function also controls the activation and deactivation of the service features. The security administration function prevents or detects unauthorized uses of services and service management functions.

Service management functions of this type are needed to provide personal communication services involving multiple service providers. Such service management functions generally require interactions between application software and various databases owned and operated by the different service providers. Consider an application which enables a nomadic user to subscribe to a personal communication service from any service provider at any location. An example of such a service is call forwarding to a temporarily rented portable phone. The application may, for example, need to perform the following database access operations at databases maintained by various different service providers:

check credit databases owned by credit card companies or phone companies to determine whether the user is able to pay for the service;

check the customer profile database in the user's HLR to determine whether the user is currently located in a place other than the visiting location currently stored in the HLR;

check the credit and network databases of long distance phone companies specified by the user to determine whether the user can use a particular long distance carrier in the visiting location;

load profile data into the VLR at the visiting location and update the HLR with the location of the VLR if necessary; and

load the profile data to the call processing systems and activate the service.

The user may need to send or receive messages from any or all of the messaging options described above at a visiting location. That is, the user may want to receive or receive notification of e-mail, faxes, phone calls, or voice mail at a visiting location or to send e-mail or faxes from a wireless terminal. The need to integrate these various types of messaging options and to interconnect the many service providers has, until now, been largely unaddressed.

It is also desirable for the mobile employee to be able to limit the messages sent to the wireless messaging equipment, so that only urgent messages are received when away from the office and unwanted in-coming calls are avoided. The mobile employee may also wish to route certain incoming wireless messages and phone calls to other destinations, such as an office fax machine or a colleague's telephone.

Therefore, it is an object of the present invention to provide a mobile service subscriber the ability to control and integrate a plurality of messaging options.

It is another object of the present invention to provide a mobile service subscriber with the ability to remotely control the addressability, routing, accessibility, and delivery of messaging options.

It is yet a further object of the present invention to provide an internetwork which interconnects messaging services with both wireless and wireline networks.

It is yet a further object of the present invention to provide a subscriber with real-time control of voice calls while using a wireless data terminal or PDA.

It is yet a further object of the invention to provide a control over the messages routed to wireless messaging options.

SUMMARY OF THE INVENTION

These objects are obtained by a personal communications internetwork providing a network subscriber with the ability to remotely control the receipt and delivery of wireless and wireline voice and text messages. The network operates as an interface between various wireless and wireline networks, and also performs media translation, where necessary. The subscriber's message receipt and delivery options are maintained in a database which the subscriber may access by wireless or wireline communications to update the options programmed in the database. The subscriber may be provided with CallCommand service which provides real-time control of voice calls while using a wireless data terminal or PDA.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the invention will become apparent from the following drawings, wherein:

FIG. 1–3 are overviews of the PCI networks;

FIG. 4 is an overview of one node of the PCI network according to the present invention;

FIG. 5 is a block diagram of an exemplary PCI server according to the present invention;

FIG. 6 is a block diagram of an exemplary embodiment of a PCI database according to the present invention;

FIG. 7 is a block diagram of the logical connections between the PCI server and PCI database according to the present invention;

FIGS. 8–11 illustrate exemplary message flows between a server and a database according to the present invention;

FIG. 12 is a block diagram of a personal digital assistant according to the present invention;

FIGS. 13–20 illustrate exemplary message flows between a PDA and PCI server;

FIG. 21 is a block diagram of a text messaging portion of a PCI network;

FIG. 22 is a block diagram of a voice messaging portion of a PCI network;

FIG. 23 is a block diagram of a facsimile messaging portion of a PCI network;

FIG. 24 is a diagram illustrating an exemplary CallCommand service network;

FIGS. 25–27 illustrate exemplary message flows in the PCI network; and

FIGS. 28–45 illustrate exemplary screens displayed to a PCI subscriber using a wireless PDA.

DETAILED DESCRIPTIONS OF PREFERRED EMBODIMENTS

For clarity of presentation, the detailed description is set out in the following subsections:

I. PCI Overview

The overall network is illustrated in FIGS. 1–4 The network is an interface between a plurality of wireless and wireline networks, providing a subscriber with a variety of wireless and wireline message and voice delivery and receipt options.

II. The PCI Server

The PCI Server is illustrated in FIG. 5. The PCI server is a peripheral which performs messaging and call redirection functions and interfaces with the PCI database to update the subscriber profile.

III. The PCI Database

The PCI Database is illustrated in FIG. 6. The PCI database maintains the subscriber profile, controls CallCommand functions, and handles DTMF-based subscriber profile updates.

IV. The Server/Database Interface

The Server/Database interface is illustrated in FIGS. 7–11. The PCI server/PCI database interface provides for the transfer of information regarding the subscriber profile and the CallCommand services.

V. The PDA/PCI Interface

The PDA/PCI interface is illustrated in FIGS. 12–20. The PDA/PCI interface provides for the transfer of information between a remote wireless subscriber and the PCI.

VI. Services

A. E-Mail Messaging

E-Mail messaging in the PCI is illustrated in FIG. 21. The PCI network provides the subscriber with a variety of e-mail delivery, receipt, and notification options, including screening and selective destination delivery of incoming e-mail.

B. Voice Messaging

Voice messaging in the PCI is illustrated in FIG. 22. The PCI provides the subscriber with a variety of voice mail delivery, receipt, and notification options, including screening and selective destination delivery of incoming voice mail.

C. Facsimile Messaging

Facsimile messaging in the PCI is illustrated in FIG. **23**. The PCI provides the subscriber with a variety of facsimile delivery, receipt, and notification options, including screening and selective destination delivery of incoming faxes.

D. CallCommand

The CallCommand service is illustrated in FIG. **24**. CallCommand service provides real-time control of voice calls while using a wireless data terminal or PDA.

VII. Message Flows

Certain message flows for wireless messaging in the PCI are illustrated in FIGS. **25–27**. The three message flows illustrated are sending a message from one subscriber to another, receiving a message regardless of whether the subscriber is using a wireless or wireline terminal, and sending a message to a non-subscriber.

VIII. The PDA Application

The application residing in the PDA is described in FIGS. **28–45**, which illustrate exemplary screens displayed to a PCI subscriber using a wireless PDA.

IX. Billing

Billing procedures for a PCI network use is briefly described.

X. Conclusion

A glossary of acronyms used in this specification is attached as Appendix A.

I. PCI Overview

FIG. 1 is a simplified overview of a personal communications internetworking ("PCI") according to the present invention. A consumer, an office for example, has various messaging equipment, such as a voice mail system **20**, an e-mail terminal **22**, fax machines **24**, and telephones **26**. These are all connected to wireline networks **29**. For example, the fax **24**, phone **26**, and voicemail system **20** may be connected to a Public Switched Telephone Network (PSTN), part of which belongs to a particular local phone service company, and part of which belongs to a particular long distance service provider. The e-mail terminal **22** may be connected to a data packet network, such as Internet, whose packets are carried over phone lines.

A mobile communications subscriber (for example an employee who works at the office described above and travels frequently) has various portable messaging equipment, such as a PDA **30**, a cellular phone **32**, and a pager **34**. These are connected to wireless networks **39**. These wireless messaging options may be provided by different service providers. That is, the cellular phone may be connected to a wireless network of a cellular phone service provider, the pager may be connected to a different wireless network maintained by a pager service provider, and the PDA may be connected to a third wireless communications network maintained by yet another service provider.

A Personal Communications Internetworking network ("PCI") **40** according to the present invention is connected between the wireless **39** and wireline networks **29**. The PCI **40** permits the mobile communications subscriber to send and receive messages between disparate networks and messaging systems and a variety of service providers. The mobile communications subscriber can receive e-mail, fax, pages, and voice messages under a single phone number while using either a wireless or wireline network. The subscriber may also select the media format and serving network used to receive messages. The subscriber may also select cross-media notification of incoming messages, (i.e., the subscriber may receive notification from a pager message that a voice mail message was received).

The subscriber selects the wireline or wireless network and media format to be used for delivering messages or notification of message receipt. The PCI **40** will perform a media conversion to allow, for instance, an e-mail message to be delivered to a fax server. The PCI **40** may also include accessibility controls which allow the user to screen messages by selected criteria such as media type (e.g., e-mail, fax, etc.), message length (e.g., voice mail messages less than three minutes), or sender (e.g., only messages from the office and a certain client are to be forwarded).

For example, the subscriber may have notification of a voice mail or fax message receipt directed to a wireless PDA in the form of e-mail messages. If the subscriber's wireless PDA is not turned on or otherwise not operating, the notification may be routed to an alternate wireless or wireline network. Notification to the subscriber that a voice mail message was received may be, for example, rerouted to the subscriber's pager, and notification that a fax has been received may be rerouted to the wireline e-mail.

FIG. **2** is a simplified version of the interconnections between various messaging systems and a PCI. As shown in FIG. **2**, a subscriber provides the network with message routing and delivery instructions. These instructions are received by a PCI database **44** and stored in a "subscriber profile" for that subscriber. This database controls the delivery of outgoing messages and the routing of incoming messages and message notification. (In FIG. **2**, wireline communications are indicated with solid line connections and wireless communications are indicated with dashed line connections. The instructions to the PCI are shown with a solid line, but as will be explained in greater detail below, the instructions may be sent either by a wireline or wireless network.)

The PCI database **44** supports access to information authenticating the subscriber's identity and validating the types of services subscribed to, the subscriber's message delivery (incoming messages) options and origination (outgoing messages) options and voice (telephone call and voice mail) options. For origination, the subscriber may select message distribution lists with specific media delivery options. The database **44** also supports access to the portions of the subscriber profile that the subscriber may control.

The subscriber may use a personal telephone number to register at alternate wireline and wireless terminals while maintaining use of the message screening and delivery options selected and stored in a subscriber's profile. This is called "personal mobility". Information about the location of a wireless or wireline network location to which the subscriber's terminal is connected automatically registers and deregisters a subscriber's terminal. This is called "terminal mobility."

FIG. **3** shows the PCI **40**. The CPE (voice mail **20**, e-mail **22**, fax **24**, and phone **26**) are connected to wireline networks **29**. The mobile subscriber equipment (PDA **30**, cellular phone **32**, and pager **34**) are connected to wireless networks **39**. Both the wireline and wireless networks **29**, **39** are connected to a PCI **40** at a service provider. The networks **29**, **39** are connected to a local exchange carrier (LEC) **42** for the personal communications internetworking.

A PCI database **44** is a physical communication system which provides call processing functions for a collection of central office switches. The PCI database **44** includes the mobile subscriber's profile, including message sending, message receiving, and service control options. The PCI database **44** may be a service control point or a network adjunct. The PCI database may be connected via a service management system (SMS) interface to a service integrator

46. The service integrator 46 allows the service provider to update subscriber data and create and modify subscriber profiles.

The PCI database 44 preferably stores and updates the subscriber profiles. The profiles contain service related information for mapping services to subscribers (e.g., screening, routing, terminal selection by subscriber selected parameters, custom calling features, and the like); subscriber authentication data (e.g., password and user I.D.); user status (registered or not registered); generic service profile for non-call associated service, such as subscriber address or social security number; specific profile for a non-call service (based on subscriber selected parameters); wireless data providers identification (e.g., what cellular phone provider is used); and specific profile for call associated services (e.g., call forwarding), based on user selected parameters.

FIG. 4 is a more detailed depiction of the one node 43 of the PCI. The PCI has a plurality of nodes and is preferably built on the Advanced Intelligent Network (AIN) architecture. Other network architectures may be used, but for illustrative purposes, the description is directed to an AIN-based network.

A PCI server 48 is a peripheral which performs messaging and call redirection functions and interfaces with the PCI database 44 to update the subscriber profile. The PCI server may be an AIN Intelligent Peripheral, such as a Bellcore Intelligent Services Peripheral, or a network adjunct. The PCI server is connected to a switch 50. In the AIN architecture, this switch is a Service Switching Point Access Tandem (SSP AT), but may be any suitable switch, depending on the architecture. The SSP AT 50 connects wireline networks to the CPE. The SSP AT 50 also connects the PCI server 48 with a central office (CO) 52. The SSP AT 50 also may connect to a Service Control Point (SCP), not shown. The PCI database 44 and the PCI server 48 are directly connected. The LEC of FIG. 3 is part of a large network and includes the PCI database 44, the PCI server 48, and the SSP AT 50. The PCI database may be connected to an SMS interface to a system integrator 46, as described above.

The PCI server 48 is also connected to various wireless and wireline networks 49 via signaling connections in these networks to transmit and receive information for all of the messaging options. Illustratively, the PCI server provides access to Public Packet Switched Networks (PPSN), Public Switched Telephone Network, (PSTN), Integrated Signaling Digital Networks (ISDN), X.25 networks and TCP/IP networks and may include access to asynchronous transfer mode (ATM), Switched Multimegabit Digital Service (SMDS), and Frame Relay networks.

The mobile subscriber may access his or her subscriber profile to change message sending, message receiving, and service control options. These option changes are sent to the PCI database 44 to be stored in the subscriber profile. FIG. 4 shows, for example, a PDA 30 connected to the PCI server 48 by a wireless network 54, but the subscriber may also use wireline e-mail, or wireless or wireline telephones (using DTMF signals) to access the subscriber profile. The messages from the PDA, for example, are sent by a wireless network 54 to the PCI server 48 using, for example, an X.25 transport.

Delivering PCI service to a subscriber who may be present on a number of different systems requires storage, movement and caching of the service profile associated with that subscriber. A mobility controller 49, located in the PCI server 48, is a controller and data store, which dynamically maintains service control information for a Message Transfer Agent (MTA), described below, in the PCI server 48, which connects the PCI server 48 to wireless data networks.

Data storage functions are handled by two tiered entities. The subscriber profile is preferably located in the PCI database 44 and is the top of the hierarchy where permanent records such as service profile, authentication and validation information, and the like of the subscriber or device are maintained and performing status and location management and mapping are performed. A service profile cache 51 is preferably located in the PCI server 48 and is a local cache entity which stores on a "needs basis" information such as service profiles and validation status and maintains a local repository for the service recipient. It also administers information necessary to serve the wireless data network entity, as well as sending updates to the permanent storage entity PCI database. The service profile cache 51 maintains the personal data associated with the processing of the mobility controller 49. The mobility controller 49 interacts with the PCI database-based subscriber profile (or third party data base) on behalf of the cache to obtain service profiles and location information related to wireless terminals.

PCI may also provide directory services as a value-added component. The X.400 MTA can query a local directory serving agent in the PCI server 48 for addressing and routing information. If the information is not local, the PCI server 48 will need to get the addressing information from another PCI server 48 at another PCI node or an interconnected private directory serving agent which maintains a separate information base. By using the existing standard, the PCI network and mail PCI servers message handling can independently manage the networks without interfering with the PCI service.

IL The PCI Server

The PCI server 48 is a peripheral which performs messaging and call redirection functions and interfaces with the PCI Database to update the subscriber profile. The PCI server performs a variety of functions. For example, an illustrative PCI server:

is an X.400 Gateway;

routes messages using the X.400 messaging protocol;

connects proprietary messaging protocols into X.400 protocol;

interfaces with wireless data networks;

interfaces with messaging systems;

interfaces with the PCI database to access subscriber profiles information;

processes messages as specified by the user in the service profile;

provides media conversion such as text to fax or fax to text;

provides access to an X.500 directory to determine addressing schemes for packet data;

supports signaling between wireless data networks for management functions such as registration; and

maintains a service profile cache.

FIG. 5 is a detailed illustration of a preferred embodiment of a PCI server 48 according to the present invention. The PCI server 48 includes three main elements: a call processor 110, a data messaging peripheral 112, and a shared disk memory 113.

The call processor 110 comprises a plurality of interconnected computers. The messaging peripheral 112 maybe implemented by a computer such as a DEC XAP system.

The call processor 110 includes a PCI applications server 114. The application server is the central decision making point of the wireless messaging service described below in Section VI. Thus, the server 114 controls message routing, screening, and notification for the wireless messaging service.

The application server **114** is connected to a PDA protocol handler **115**. The protocol handler is the interface to the wireless network **54**, for example the RAM wireless network. This handles messages to be sent to and from the subscribers PDA **30**. A plurality of personal digital assistants (PDA) **30** are connected to the wireless network **54**.

The application server **114** also manages a PCI database protocol handler **126**. The protocol handler **126** is the interface between the call processor **110** and the PCI database **44**. The application server **114** also manages a Service Profile Cache **51**. The Service Profile Cache **51** is maintained in the memory of the application server **114**. The cache **51** stores a subset of the data in the subscriber profile stored in the PCI database **44**. This subset is subscriber profile information which currently needs to be accessed frequently by the PCI server **48**.

The Service Profile Cache **51** stores and accesses data related to access systems such as wireless data providers and messaging services, and subscriber location. The Service Profile Cache **51** may store and update data related to the subscriber location such as routing address for subscribers specific wireless terminals; store and updates services related data for a particular terminal type (such as uni- or bi-direction); maintain a list of the subscribers wireless data provides and message services; track the subscribers terminal status (registered or not registered); provide a generic service profile for non-call messaging service; and provide a specific profile for a non-call associated service based on subscriber selected parameters.

The application server **114** also manages the registration status of each application on each PDA **30** and controls customer profile information via each PDA **30**.

The call processor **110** also includes an IP Functions Server **130**. The IP Function Server **130** manages CallCommand applications. This server is also connected to the PCI database protocol handler **126** for communication with the PCI database **44** and the PDA protocol handler **115** for communication with the wireless network **54**. The PCI database protocol handler **126** handles both interfaces between the PCI database and the PCI server, as described below.

Thus, the two main application servers in the call processor **110** are the IP Function server **130** for CallCommand applications and the PCI applications server **114** for wireless messaging services.

The call processor **110** also includes a plurality of communication interfaces. The protocol handlers **115** and **126** have already been discussed. The alphanumeric paging server (APS) **132** gives the call processor **110** the ability to provide alphanumeric paging services. The APS **132** includes one or more modems to communicate with terminal equipment of a network **134** maintained by a paging service provider. The APS communicates with the paging service provider using, for example, the TAP protocol (Telocator Alphanumeric Protocol).

The call processor **110** also includes a plurality of control processes which control peripheral equipment external to the call processor **110**. These controllers are as follows:

A message controller **136** controls the data messaging peripheral **112** and controls the sending of messages between the call processor **110** and the data peripheral **112**.

The mobility controller **49** comprises the PCI database protocol handler **126**, the IP function server **130**, the service profile cache **51**, and the PCI application server **114**. The mobility manager provides control logic for user authentication, service request validation, location management, user access to service profile, access registration, and communication management such as routing to user-specified destinations. The mobility controller **49** contains the service logic and handles service related processing for personal data and service access such as service feature analysis; access system mapping relationship information; identity management; subscriber validation and authentication; billing information based on the subscriber; wireless data specific routing information for message delivery and subscriber paging; subscriber service validation; and subscriber review and modification of the subscriber's profile.

A transaction controller **150** controls a switch controller **152** and a voice peripheral controller **154**. The switch controller **152** controls the digital switch **156** which connects to the public switched telephone network **58**. The voice peripheral controller **154** controls the voice peripherals **160**, which are for example text-to-speech converters.

The switch **156** and the voice peripheral **160** are also connected by a T1 line **161**. The digital switch **156** is connected to the public switched telephone network by a plurality of transmission media such as T1 lines **162**, fax lines **163**, and ADSI lines **164**.

The data messaging peripheral **112**, which is optional, is now discussed in greater detail. The data messaging peripheral is the gateway to the wireline electronic mail network, which network is designated **170**. The data messaging peripheral has a message transfer agent **158** for transferring messages between the call processor **110** and the data networks **170**, **54** either directly or through the PDA Protocal handler **115**. The messaging peripheral **112** also includes a POP (post office protocol) server **190** and associated memory **192** for providing a message storing capability. The message directory **19** is used for storing a subset of service profile cache **51** relating to the routing of e-mail messages.

The messaging peripheral **112** includes the message gateway **140**. The message gateway **140** has the following capabilities:

1) Notifying the PCI application server **114** in the call processor that e-mail has arrived from the wireline e-mail network **170** for a subscriber.

2) Accept a request from the PCI application server **114** to send an e-mail message to a wireline address.

3) Accept a request from the application server **114** to provide all unread messages stored in the server **190** which would have been sent to a primary destination if the subscriber had been registered.

4) Accept a request from the application processor **114** to rewrite to the message store server **190** or back to the sender.

Using the call processor **110** and its associated peripherals, a wide variety of services may be performed. These have been discussed above briefly and are described in detail in Section VI below. However, to understand how the call processor **110** operates to provide these services, some exemplary descriptions for certain services is provided.

For example, when a wireline e-mail message arrives at the PCI server's Data Messaging Peripheral **112**, the messaging gateway **140** and messaging Controller **136** send notification to the PCI application server **114** of the e-mail arrival. The PCI application server **114** will query the profile cache **51**, or if necessary, the PCI database **44**. Driven by data in the subscriber's profile, the PCI application server **114** executes service logic to determine where to forward the e-mail (i.e., forward to PDA **30** or to POP server **190** depending on screening outcome), and what media, if any, to use to send notification of the e-mail arrival.

For another example, when a CallCommand call arrives at the PCI server **48**, the procedure is as follows. The switch

controller 152 and transaction controller 150 forward the call to the IP Functions Server 130 based on the dialed number. The IP functions 130 sends a provide_instructions 1129+ message to the PCI database 44 to determine how to handle the call. The PCI database 44 and IP functions applications servers 130 begin a conversation of messages which perform a sequence of functions which play an announcement to the caller, send notification to the PDA, etc. When a response arrives from the PDA 30, the IP functions server 130 forwards the response to the PCI database 44. The PCI database 44 will then direct IP functions server 130 to forward the call to a routing number and/or play a synthesized message to the caller.

If a subscriber wishes to update the subscriber profile by DTMF, the procedure is as follows. A call arrives at the PCI server 48. The switch controller 152 and transaction controller 150 forward the call to the IP functions server 130 based on the dialed number. The IP functions server 130 sends a provide_instructions 1129+ message to the PCI database 44 to determine how to handle the call. The PCI database 44 sends a request to play an announcement and collect digits ("please enter PIN", collect PIN). The IP functions server 130 returns the result of this request to the PCI database 44. Again the PCI database 44 sends a request to the IP functions server 130 to play an announcement and collect digits ("voice menu", menu selection). The IP functions server 130 returns the result of this request to the PCI database 44.

This process repeats as users are guided through menus and change profile elements. The PCI database 44 interprets the collected DTMF tones and updates the subscriber's profile accordingly.

When a PDA 30 sends an e-mail message addressed to a wireline address the procedure is as follows. The PDA 30 sends a UDP send_mail message to the PCI application server 114. The PCI application server 114 detects the message is not destined for another PCI subscriber and forwards the request to the messaging controller 136, which forwards it to the messaging gateway 140 which is in the Data and Messaging Peripheral 112. The messaging gateway 140 interfaces with the MTA 158 to send the e-mail to the wireline network 170, using, for example, the Simple Messaging Transfer Protocol (SMTP).

The PCI server 48 may be based, for example, on either an X.400 MTA or an SMTP router and can convert between both protocols. The PCI server 48 may receive text messages from a variety of different text messaging systems such as Internet mail, third party messaging systems, or proprietary messaging systems. In the example where PCI routes messages using an X.400 MTA, these messages must be converted to conform with X.400 protocol before they can be routed. Thus, an exemplary messaging gateway is an X.400 gateway, which can be designed and built by a person of ordinary skill in the art.

II. The PCI Database

A PCI Database 44 maintains the subscriber profile, controls the Call Command functions, and handles DTMF-based subscriber profile updates.

The PCI database architecture shown in FIG. 6 comprises several application and support components. The application components include Multiple Services Application Platform (MSAP) 202; Service Provisioning and Creation Environment (SPACE) 204; and Data and Report Subsystem (DRS) 206.

The service components include the Maintenance and Operation Console (MOC) 208; the Intelligence Peripheral Interface (IPI) 210; the Generic Data Interface (GDI) 212; the Service Network Interface (SNI) 214; and the Data and Report database (D&R) 218.

The service network interface (SNI) 214 provides a communication interface to external systems such as switch 50 and PCI server 48. These interfaces include the IPI 210 and GDI 212 which connect the PCI database to the PCI server via the TCP/IP network 213. The GDI 212 is used for uploading and downloading a subscriber profile to the PCI server 48. The IPI 210 is used for transmitting DTMF commands from a user via the PCI server 48. For redundancy, each intelligent peripheral interface (IPI) and generic data interface (GDI) processor preferably requires two logical connections to the PCI server.

The Multiple Services Application Platform (MSAP) 202 includes a call processor 220, a first call process request (CPR) database 222, an MSAP common 224, a shared memory 226, and a call contact database (CCDB) 228. The call processor 220 receives messages from and sends messages to a message distributor 219 in the SNI 214. The message distributor determines whether the message received from the call processor 220 is to be sent to the IPI 210 or the GDI 212. The call processor receives messages from the message distributor and sends them to the first CPR database, the CCDB 228, and/or the shared memory 226. The first CPR database 222 stores the subscriber profiles. The MSAP 224 connects the first CPR database 222 with the second CPR 230, which resides in SPACE 204. MSAP common 224 updates one of the CPR databases 222, 230 when changes have been made to the other CPR database. The CCDB 228 is a temporary, dynamic storage for storing subscriber profiles, and related data during profile update procedures. The shared memory 226 allows different processors to use the same data.

SPACE 204 is a service provider-operated module through which new PCI database applications are created and new subscriber profiles are initiated. SPACE 206 includes the second CPR database 230 which contains the identical information as the first CPR database 222 in MSAP 202. When a new subscriber profile is to be created, a service provider uses a display terminal 232 in SPACE to provision a new service profile including certain subscriber information. The subscriber profile is activated through MSAP when the user initially registers. Service provider changes made to the second CPR database 230 are transmitted to the first CPR database 222 in MSAP via the MSAP common 224. Changes made to the second CPR database 230 by a service provider are not transmitted to the service profile cache 51 in the PCI server 48 until a later time. That is, the PCI database 44 does not send data to the PCI server 48 unless requested by the server 48. The server profile cache 51 will be updated with this new information the next time the PCI server 48 requests a profile download, for instance when the subscriber next registers. SPACE 204 provides a function parallel to the Service Management System described above.

The Data and Report Subsystem (DRS) 206 collects data about the PCI database 44 usage which may be helpful to the service provider. For example, errors made by the subscriber when updating the user profile are noted. The types of alterations made, times such alterations are made, and the like are also stored for future use by the service provider.

MOC 208 is a network maintenance support system which monitors the status of the network and checks for system failures and the like.

When a subscriber wishes to update the subscriber profile using a PDA 30, the procedure is as follows. The PDA 30 communicates with the PCI server 48. The PCI server 48

sends a GetData message having a "Service Key", which is preferably a ten digit PCI subscriber number (e.g., a telephone number), to the PCI database **44** over the GDI **212**. The GDI **212** translates the GetData message into a format understandable by the PCI database **44**. The message is sent through the message distributor **219** and call processor **220** to the first CPR database **222** where the subscriber profile resides. The Service Key is used to obtain the correct subscriber profile and the profile is sent through the call processor **220** to the message distributor **219**. The message distributor determines that this message is to be sent to the PCI server **48** via the GDI **212**. (The reason for this is discussed below.) The GDI **212** translates the data into a format suitable for the TCP/IP network and is transmitted to the PCI server **48**. The requested changes are performed in the PCI server **48** and the updated profile is sent back to the PCI database **44** through the TCP/IP network, the GDI **212**, message distributor **219**, call processor **220** and to the first CPR database **222**. The call processor **220** also sends a message through the GDI **212** to the PCI server **48** which will send a wireless transmission to the PDA **30** acknowledging the subscriber profile update. The changes are also sent to the MSAP common **224** where they are sent to the second CPR database **230** in SPACE **204**.

During this process, information may be temporarily stored in the Call Contact Database (CCDB) **228**. The CCDB database **228** provides temporary storage for subscriber profile updates that are suspended because they are waiting for action by a subscriber or waiting for data from an external system, such as the PCI server **48**. During the time intervals between action by the user or delays in receiving data from an external system, the call processor **220** stores the information in the CCDB database **228** and processes other calls.

When a subscriber desires to update his or her subscriber profile using a touch tone phone, the procedure is as follows. The subscriber calls, for example, a service number provided by the service provider. The call is routed to the PCI server **48**. The PCI server **48** sends a message to the PCI database **44** via the IPI **210** that the DTMF commands are present. The message is sent through the message distributor **219** to the call processor **220**. The appropriate subscriber profile is retrieved from the first CPR database **222** in the MSAP **202**.

The call processor **220** instructs the PCI server **48** to play a voice announcement instructing the caller to enter the subscriber ID and password, by pressing the appropriate digits on the touch-tone phone. The information is entered by the caller, and the PCI database **44** validates this information. If the validation determines that the caller is an authorized subscriber, the PCI database **44** instructs the PCI server **48** to ask the subscriber to select which subscriber profile information is to be modified. Only two fields are modifiable using DTMF messaging: changing a wireline registration or recording a personalized greeting. The subscriber selects either registering at a wireline phone or recording a personalized greeting. If wireline registration is selected, the PCI database **44** instructs the PCI server **48** to prompt a ten digit telephone number to which all incoming calls will be routed. If the subscriber selects to record a personalized greeting, the PCI database **44** instructs the PCI server **48** to prompt the subscriber for a new greeting.

If invalid information is entered at any time, the PCI server **48** plays an error message to the subscriber and the subscriber retries the modification. If the retry fails, the call is terminated. Otherwise, the subscriber's profile is updated according to the modification, data synchronizing the messages are sent to the PCI server **48** and the call processor **220** instructs the PCI server **48** to inform the subscriber that the PCI service profile was updated.

The call processor **220** also sends a message through the message distributor **219** to the GDI **212** and to the PCI server **48** which updates the service profile cache **51** in the PCI server **48**. The changes stored back in the first CPR database **220** are sent to the MSAP common **224** where they are sent to the second CPR database **230**. Note that DTMF function signals, which use the **1129** + protocol, are routed through the IPI **210** and that the subscriber profile data, which uses the GDI protocol, are routed through the GDI **212**.

IV. The PCI Server/Database Interface

The interface between the PCI server **48** and the PCI database **44** is based on two protocols. The first protocol is **1129+**. This protocol will be used to support the PCI Call Command feature and for subscriber initiated profile manipulation using DTMF. The second protocol is Generic Data Interface. The GDI is used for subscriber profile management, specifically downloading a subscriber profile from the PCI database **44** to the PCI server **48** and for applying updates to the profile stored in the PCI database **44**.

FIG. **7** shows the logical links from the PCI database **44** to the PCI server **48**. The PCI database **44** consists of a mated pair of PCI databases **44***a*, **44***b*, each containing three call processors **220** which each share the load. The links **250** are TCP/IP links between Intelligent Peripheral Interface (IPI) **210** and the Generic Data Interface (GDI) **212** processors on the PCI database **44** to the PCI server call processor. Two logical connections are made from each IPI **210** and GDI **212** processors to the PCI server for redundancy. Thus, a full SCP configuration supporting PCI would preferably require 24 logical links, as shown in FIG. **7**. The PCI database initiates the opening of the logical links.

In this illustrative embodiment, the CallCommand feature employs the **1129+** protocol. For the wireless messaging feature, PCI uses the GDI protocol. The GDI tag IDs assigned for the PCI subscriber profile elements are provided in Appendix B.

Appendix B also shows the PCI profile data, including the profile elements, their data types, maximum lengths, and GDI tag IDs. An * indicates elements which were shortened to 32 bytes because of GDI byte limitations. The description of the types and lengths of these elements is as follows:

dN BCD-encoded digits. The number N represents the maximum number of BCD digits, not octets.

cN Up to N ASCII characters.

cN Binary integer N bytes in length, in network byte order (highest order bit transmitted first).

Because the portion of the PCI subscriber profile downloaded to the PCI server is large (preferably approximately 1,000 bytes), and a maximum Transaction Capable Application Program (TCAP) message size is 256 bytes, the profile must be managed in segments. The service profile is divided into six segments as shown in Table 1. Each segment is assigned a unique numeric identifier.

PCI Profile Segment	Segment ID (decimal)
Personal data	1
CC service profile	2
E-mail routing	3
E-mail subject screening	4
E-mail from screening	5
Voice mail profile	6

Certain data in a subscriber profile provides a subscriber's preferred media for messages delivery and notification. The

encoding for these types are given in Table 2.

Media Type	Code
Alphanumeric Pager	A
E-mail message store	S
Fax	F
PDA	P
Voice mail	V
Wireline e-mail	E
Null	Z

For example, if the subscriber prefers to receive e-mail which passes screening via the PDA **30**, then the "primary destination one" profile element will contain a "P".

FIG. **8** illustrates a message flow for profile retrieval using the GDI protocol. A subscriber attempts to register with the PCI server either explicitly or implicitly (registration is discussed in detail below). The PCI server **48** send a GDI GetData query to the PCI database **44** over one of the GDI links (line **260**). The PCI server **48** may send one GetData data query for each PCI profile segment. Each query will be processed by the PCI database **44** as an independent transaction with a unique TCAP transaction ID. Each GetData query sent by the PCI server **48** will include a "Service Key" parameter which is a ten-digit PCI subscriber number (e.g., a telephone number). This key should be used by the PCI database **44** to identify the subscriber. In each GetData is a list of tag IDs listed in the profile elements to be retrieved. The PCI database **44** responds to the GetData data query with a GetData response (line **262**). The response contains a return code and data for each element requested in the GetData data query.

FIG. **9** provides a message flow between the PCI server **48** and the PCI database **44** for a profile update originating from a wireless PDA **30**. This wireless profile update uses the GDI protocol. A subscriber performs a profile manipulation activity, and the PDA **30** sends a profile data message to the PCI server **48**. The PCI server **48** sends a GDI SendData query to the PCI database **44** over one of the GDI links (line **264**). The PCI server **48** may send one SendData query for each PCI profile segment for which a profile element was updated. Each query will be processed by the PCI database **44** as an independent transaction with a unique TCAP transaction ID.

Each Send Data query sent by the PCI server **48** will include a "Service Key" parameter which is the ten digit PCI subscriber number. This key should be used by the PCI database **44** to identify the subscriber. Each SendData query contains a list of tag IDs provided in Appendix B and data for the profile elements to be updated. Not all tags in this segment may be included in the SendData query; only those profile elements which are actually updated by the subscriber will be sent. The PCI database **44** should not update data for which no tag was included in the SendData query.

The PCI database **44** responds to the SendData query with a Send Data response (line **266**). The response contains a return code for each element requested in the SendData query.

FIG. **10** is an illustrative example of one possible CallCommand message flow between the PCI server **48** and the PCI database **44**. (CallCommand is discussed in more detail in section VI D.) The exact call flow for CallCommand depends upon the implementation of the service logic by the service designer and upon options selected by the CallCommand subscriber. The CallCommand functions illustratively use the **1129+** protocol and the IPI **210** (see FIGS. **6** and **7**).

As illustrated in FIG. **10**, a CallCommand call arrives in the PCI server **48**. The PCI server **48** sends a provide_instructions query to the PCI database over one of the **1129+** links (line **268**). A TCAP transaction ID is generated for the query. The dialed number digits parameter contains the personal numbers of the PCI subscriber (i.e., Service Key). The ANI digits contain the automatic number identification, if any, of the caller (ANI is a telephone network capability). The PCI database sends a **1129+** send_to_resource command to the PCI server **48** to play an announcement and collect digits (line **270**). The PCI server **48** plays the announcement, collects the digits, and sends a response containing a return code and the digits collected (line **272**).

PCI database **44** sends a **1129+** play_application command to the PCI server **48** to notify the PDA **40** of the incoming call (line **274**). The PCI server **48** responds with a return code and a destination number (entered by the subscriber at the PDA **30**) to which the call is routed (line **276**). The PCI database **44** sends a **1129+** switch_to_resource command to the PCI server **48** instructing the PCI server **48** to route the call to a destination number (line **278**). The PCI server responds with the return code executing that request (line **280**).

FIG. **11** is an illustrative example of one possible message flow between the PCI server **48** and the PCI database **44** for a DTMF profile manipulation message. The DTMF profile manipulator uses the **1129+** protocol through the IPI **210**. The exact call flow for DTMF profile manipulation depends upon the implementation of service logic by the service designer and upon options selected by the PCI subscriber.

As shown in this illustrative example, when a call arrives at the PCI server, the PCI server sends an **1129+** provide_instructions query to the PCI database (line **282**). The called number contains a dialed number (i.e., the service number for a DTMF updates), while the ANI field contains the ANI, if any. The PCI DTMF profile manipulations Call Process Request CPR is triggered by the dialed service number. The CPR **222** instructs the PCI server to play announcements and collect digits, guiding the subscriber through voice menus and prompts lines **284**, **288**. The PCI server responds to each request with digits collected (lines **286**, **290**, **294**). The CPR updates subscriber's profile with data collected via DTMF.

V. PDA/PCI Interface

Communication between the PDA and PCI use, for example, an X.25 transport using the UDP IP protocol. A brief discussion of the PDA structure is provided. The PDA **30** is preferably a notebook or palm top computer having a wireless network interface. The PDA may be, for example a Hewlett Packard Omnibook 300 notebook computer running a PCI application. FIG. **12** illustrates an exemplary PDA. The PDA **30** has a central processing unit **294** connected to a bus B. The central processing unit ("CPU") **296** performs most of the computing and logic functions of the PDA **30**. A memory **296** is connected to the bus B, which stores information to be provided to the CPU **295** or otherwise used by the PDA **30**. An input/output device **297**, such as a keyboard, is also connected to the bus B which allows a user to input data for storage in memory **296** or for use by CPU **295**. A display **298** is connected to the bus B. The PDA **30** also has a wireless communication interface **299** for communication with a wireless communication network.

The PDA/PCI interface involves six types of message flow. These messages are: (1) registration/deregistration; (2) wireless messaging; (3) retrieving E-Mail; (4) cross-media notification; (5) CallCommand; and (6) profile management.

There are two types of registration and deregistration: explicit and implicit. Explicit registration occurs when a PCI

subscriber starts the PCI application software on the PDA **30** (this is called start-up registration) or when the subscriber clicks a status check button or one of the service registration request buttons on the PDA **30** either for the CallCommand or wireless messaging service. Once successfully registered, if the subscriber's profile is not already present in the service profile cache **51** maintained by the PCI server **48**, the PCI server **48** will request a download of the subscriber's profile from the PCI database **44** to the service profile cache **51**. The PCI server **48** sets the subscriber's registration status in the cache **51** to match those requested by the subscriber for the wireless messaging service for the call command service.

FIG. **13** illustrates one example of the message flow between the PDA **30** and PCI server **48** during explicit registration. This flow is also used by a subscriber to check registration of CallCommand or wireless messaging services. A subscriber starts the PCI application software on the PDA or clicks the service status check, CallCommand registration, or wireless messaging registration buttons on the PDA. The PDA sends a registration request to the PCI server **48** with the subscriber's validation information (subscriber ID and password) (line **300**). The PDA **30** also starts a timer during which the PDA **30** will wait for a response from the PCI server **48**. The PCI server **48** server receives the registration request and checks if the subscriber is provisioned and if the subscriber ID and password are correct. The PCI server then sends a registration acknowledgement (line **302**). If the subscriber is not provisioned, no service profile exists and the acknowledgement includes an "unrecognized subscriber" response. If the subscriber ID and password are invalid, the acknowledgement includes an "incorrect password/PIN" response. Otherwise, the PCI server acknowledgement includes a "success" response. If the PDA **30** does not receive an acknowledgement from the PCI server within a predetermined time, it aborts the registration attempt and tells the subscriber to try again later.

Implicit registration automatically registers a subscriber for the wireless messaging service when the subscriber is currently not registered and wishes to send or fetch E-Mail from or to a PDA **30**. Implicit registration is done as follows. The PCI server receives a fetch or send request from a subscriber who is not registered for the wireless messaging service. The PCI server **48** retrieves a copy of the subscriber's service profile from the PCI database **44**, if necessary, and validates the subscriber's ID and password. The PCI server **48** validates the profile contents to make sure that subscriber may use the wireless messaging service. If wireless messaging is permitted, the PCI server **48** processes the request. Otherwise, it sends an acknowledgement indicating the reason why the subscriber is not permitted to use the wireless messaging service. The message flow is the same as illustrated in FIG. **13**.

Once the subscriber is registered for either the CallCommand service or the wireless messaging service, the subscriber remains registered until the subscriber explicitly deregisters by either quitting the application or clicking the deregistration button on the PDA **30**. The subscriber can also be implicitly deregistered for the wireless messaging service by the PCI server **48** provided the PCI did not detect any wireless messaging activities to or from that subscriber for a given duration of time. Although the subscriber is deregistered, the subscriber's service profile will remain in the service profile cache **51**. The profile remains in the cache as long as the PCI server has some activity for the subscriber, such as incoming e-mail messages within a predetermined time, such as four hours.

No PDA-to-PCI server messages may be sent by the subscriber to implicitly register for CallCommand, thus, a subscriber should not be implicitly deregistered from this service. Implicit registration and deregistration occurs only for the wireless messaging service and not for CallCommand. A subscriber remains registered for CallCommand as long as he or she is running the CallCommand software application on the PDA.

Explicit deregistration occurs when a subscriber quits the PCI application software on the PDA (this is called exit deregistration) or when the subscriber clicks one of the service deregistration request buttons on the PDA for the CallCommand or wireless messaging services. FIG. **14** is an illustrative embodiment of a message flow between the PDA **30** and PCI server **48** for explicit deregistration. A subscriber quits the PCI application software on the PDA or clicks a deregistration button on the PDA. The PDA **30** sends a deregistration request to the PCI server **48** with the subscriber's validation information (the subscriber ID and password) (line **304**). The PDA **30** also starts a timer during which the PDA will wait for a response from the PCI server **48**. The PCI server **48** sends an acknowledgement (line **306**). The PCI server **48** receives the deregistration request and checks if the subscriber ID and password are correct. If the subscriber ID and password are not correct, the acknowledgement includes an "incorrect password/PIN" response. Otherwise, the acknowledgement includes a "success" response. If the PDA **30** does not receive an acknowledgement from the PCI server **48** after a predetermined time, the PDA **30** assumes that it is out of radio coverage and informs the subscriber to retry later.

Implicit deregistration occurs when the PCI does not detect any wireless messaging activity from or to the subscriber for a given duration of time, for example four hours. The PCI will also try to implicitly deregister a subscriber from the wireless messaging service in the middle of the night in the event that the subscriber inadvertently left the PDA **30** turned on. The PCI server **48** keeps a time-stamp of the most recent wireless messaging activity for each registered subscriber in the subscriber's service profile maintained in the service profile cache **51**. Whenever the PCI server **48** detects any wireless messaging activities to or from a particular subscriber, the time-stamp is updated to the current time. The stored time-stamp of a registered subscriber is periodically compared to the current time. When a predetermined time elapses, the PCI server **48** assumes that the subscriber is out of radio coverage or has quit the PCI application.

For implicit (or automatic) deregistration, the message flow is the same as illustrated in FIG. **14**. The PCI server **48** sends to the PDA **30** a deregistration request containing registration information about the subscriber. The PCI server **48** also sets a timer during which it will wait for a response from the PDA **30**. When the PDA **30** receives the deregistration request, it responds with registration acknowledgement which contains the registration information currently known to PDA. When the PCI server **48** receives the registration acknowledgement, it updates the subscriber's registration status based on information in the acknowledgement. The PCI server **48** also updates the wireless messaging time-stamp associated with the subscriber to the current time. If the PCI server **48** does not receive an acknowledgement within a predetermined time as described above, the PCI server **48** assumes that the subscriber is no longer registered and removes all references to the subscriber from the service profile cache **51**.

Sending and receiving e-mail wireless messages involves two types of message flows: sending messages from the PDA **30** to the PCI server **48** and from the PCI server **48** to the PDA **30**.

FIG. 15 is an illustrative example of a message flow sending an E-mail from a PDA 30 to an PCI server 48. When a subscriber sends an E-Mail notification from the PDA 30, the PDA 30 forwards the E-Mail notification to the PCI server 48. The body of the E-mail contains, for example, "to;from;subject;cc" information (line 308). The PCI server acknowledges this notification (line 310). If the E-mail is longer than can be transmitted in a single message, the PDA 30 segments the E-mail into multiple, sequentially numbered messages and sends them to the PCI server (lines 312, 316, 320). Each message sent from the PDA is responded to with an acknowledgement containing the reception status of the message and the sequence number it is acknowledging (lines 314, 318, 322). The PDA 30 and PCI server 38 use the sequence number to maintain a sequential flow of packets. Out of sequence messages are discarded. Once all of the packets are received, the PCI server 48 puts them into their original order using the sequence number and forwards the now assembled E-mail to a message transfer agent, which then forwards the E-mail to its intended destination.

The PDA 30 starts a timer each time it sends out an E-mail. If the PDA 30 does not receive an acknowledgement after a predetermined time (for example ten seconds), the send operation is aborted and the E-mail is stored in a local outbound queue for redelivery in the future.

When an E-mail is being delivered from an PCI server 48 to a PDA 30, a similar message flow is used. The only difference is that the PCI server 48 initiates the flow and sends the initial messages instead of the PDA 30.

Retrieving E-mail involves two types of message flows: retrieving undelivered E-mail addressed to the PDA 30 and retrieving E-mail delivered to a messaging system, such as a wireline e-mail system. When a subscriber is out of radio coverage or is not registered with PCI, the PCI sends E-mails addressed to be delivered to the PDA (PDA-bound E-mail) to an external mail storage system. The PCI server will also send certain E-mail directly to an external mail storage system (MS-bound E-mail), such as the subscriber's wireline E-mail connected to his or her personal computer, according to the subscriber profile stored in the PCI database 44.

A registered subscriber can retrieve PDA 30 bound E-mail at any time by starting "FETCH" operation. The PCI will send the PDA bound mail from the external mail storage and will also summarize MS-bound E-mail.

An illustrative example of the message flow between the PDA and the PCI server for retrieving undelivered PDA bound E-mail is shown in FIGS. 16(*a*) and (*b*). If there are no MS-bound messages, an illustrative message flow is shown in FIG. 16(*a*). The PDA 30 sends a fetch request to the PCI server 48 (line 324) and starts a timer, which waits for an acknowledgement. If no acknowledgement is received within a predetermined time, for example twelve seconds, the PDA 30 assumes it is out of radio coverage and informs the subscriber to try again later. In response to the request, the PCI server 48 logs into an external mail storage system specified in the subscriber's profile. If any PDA-bound E-mail is stored in the external storage system, the PCI server 48 will (a) move the PDA bound E-mail from the external mail storage system into a pending area in the PCI server; (b) send an acknowledgement to the PDA indicating the number of PDA bound E-mail now residing in the pending area; and (c) initiate delivery of these PDA bound E-mail from the pending area to the PDA (line 326).

If there are MS-bound E-mail messages, an illustrative message flow is shown in FIG. 16(*b*). The PDA sends a fetch request (line 328) and starts a timer. Whenever the PCI server sends a summary message, it starts a timer. If the PCI server 48 does not receive an acknowledgement within a certain predetermined time, for example ten seconds, it will assume that the PDA 30 is out of radio coverage, abort the send operation and discard the summary information. In response to the request, the PCI server 48 will (a) send an acknowledgement to the PDA indicating the number of MS-bound E-mail present (line 330); (b) extract summary information from those messages; and (c) send the summary to the subscriber's PDA (line 332). When the PDA receives an acknowledgement from the PCI server, it informs the subscriber based on the contents.

Summary information for the MS-bound E-mail is formatted into one ASCII text per E-mail and sent to the PDA. If the summary information, or the number of summarized E-mail require more than one message, the PCI server 48 splits the summary information into multiple sequentially numbered segments and sends each segment in a separate message (lines 336, 340). Each message from the PCI server 48 is responded to by the PCI server with an acknowledgement containing the reception status of the message and the sequence number it is acknowledging (lines 334, 338, 342). Out of sequence messages are discarded. Once all of the packets are received, the PDA 30 puts them into their original order using the sequence number.

Once the summary information describing the MS-bound E-mail messages is reviewed, the subscriber may start a FETCH operation to retrieve these MS-bound E-mail messages. FIG. 17 is an illustrative example of a message flow between the PDA 30 and the PCI server 48 retrieving MS-bound E-mail. The subscriber selects an MS-bound E-mail message to be received. The PDA 30 sends a retrieve request to the PCI server 48 containing the message selected by the subscriber (line 344). The PCI server 48 responds with an acknowledgement (line 346). The PCI server 48 logs into the external message storing system specified in the subscriber's service profile and moves the MS-bound E-mail specified in the request out of the storage system into a pending area in the PCI server 48. The PCI server 48 initiates a send operation which delivers the E-mail in the same manner as discussed above.

Cross media notification (e.g., PDA notification of voice mail message receipt) is sent to the PDA 30 using the same delivery as a wireless E-mail message to the subscriber. The PCI server 48 originates the notification E-mail and the e-mail subject is "message notification". The body of the notification E-mail contains the message sender's address (i.e., the phone number for a voice mail), the date and time the message arrived at the PCI; the type of media, (i.e., voice mail, FAX, E-mail or other); whether the message is marked urgent (if detectable); the length of the message (for example, in minutes for a voice mail message); and, if appropriate, the subject of the message.

CallCommand allows a PCI subscriber to reroute or direct calls in real time. The subscriber may receive notification on the PDA 30 that a call is waiting. Using the PDA 30, the subscriber may instruct the PCI to route the call to specified destination number or have the PCI server play a message entered by the subscriber using synthesized speech.

When a call is made to a CallCommand subscriber's number, it is routed to an PCI server 48. The PCI server 48 queries the PCI database 44 to determine how the subscriber's profile has directed the call to be processed. If the subscriber is registered at a known telephone number, the PCI database 44 instructs the PCI server 48 to route the incoming call to the given telephone number (assuming that the call meets any screening requirements). If the subscriber

is not registered at a known telephone number, the PCI database 44 will provide a default routing number and a timer value instructs the PCI to play an announcement customized by the subscriber to the caller and start collecting DTMF digits within that time period. The PCI plays the announcement and starts the timer provided by the PCI database 44 and then begins collecting DTMF digits entered by the caller. If no digits are collected within a predetermined time period, the PCI routes the call to a default number indicated by the subscriber's profile in the PCI database 44. If DTMF digits are collected, the PCI puts the caller on hold, determines if the caller meets the screening requirement, and handles the call accordingly. If the call is to be directed to the subscriber, the PCI attempts to contact the subscriber.

FIG. 18 is an illustrative example of the message flow between the PDA 30 and PCI server 48 for a CallCommand call. The PCI server 48 sends a notification message to the subscriber's PDA 30 to notify the subscriber that a call is waiting (line 348). The message contains the DTMF digits entered by the caller. The PCI server 48 starts two timers, which are the time interval the PCI server 48 expects to receive an acknowledgement from the PDA 30 and the time interval the PCI server 48 expects to receive a response from the PDA 30, respectively. The typical values for these timers are ten and forty seconds, respectively. The time to receive an acknowledgement should be less than the time for the response.

After receiving a notification message, the PDA sends an acknowledgement to the PCI (line 350). This informs the PCI server 48 that the PDA 30 is within radio coverage and that the subscriber has been notified about the incoming call. Once the acknowledgement is received, it cancels the acknowledgement timer, but leaves the response timer ticking, waiting for a response to come from the PDA 30. If the PCI server 48 does not receive an acknowledgement within the predetermined time, it assumes that the PDA is either out of radio range or is turned off and cancels the response timer and routes the call to a default number programmed into the user profile in the PCI database 44. The subscriber is notified of the incoming call by the CallCommand interface on the PDA 30. The DTMF digits entered by the caller provide the subscriber with the name and/or telephone number of the incoming caller.

The subscriber can decide to route the call to directory number or voicemail, enter a text message to be played to the caller, or both. The PDA will send a response to the PCI server 48, which carries the number to which the call should be routed, a short text message to be played to the caller through synthesized voice, or both (line 352). When the PCI server receives the response, it cancels the response timer and executes the subscriber's decision in the response and sends an acknowledgement which contains how the subscriber's decision is to be carried out (line 354).

If the response timer expires before the PCI server 48 receives a response, the PCI server 48 routes the call to a default number obtained from the PCI database 44 and send a status message to the PDA 30 to inform the subscriber that the caller is no longer waiting (line 356). Also, if the caller decided not to wait any longer (that is hangs up or presses "*", which allows the caller to go to the default number) the PCI sends a status message providing this information. The PDA acknowledges the status message (line 358).

Profile management allows the subscriber to modify wireless messaging and Call Command services by updating certain elements in the subscriber's service profile stored in the PCI database 44 and the service profile cache 51 in the PCI server 48. Profile information is not stored locally on a PDA 30. Updating the subscriber's profile using a PDA 30 always requires the subscriber to the PCI.

Profile management involves two types of message flows, profile download and profile upload. FIG. 19 is an illustrative example of the message flow between the PDA 30 and the PCI server 48 for a profile download. As indicated above, any profile change requires a profile download because the profile is never stored in the PDA 30. A subscriber starts a profile management application on a PDA 30 and requests a profile download. The PDA 30 sends a download request to the PCI server and requests a copy of the subscriber's modifiable profile elements to be downloaded to the PDA 30 (line 360). The PCI validates the identity of the subscriber through its subscriber ID and password. If the subscriber's identity is not validated, the PCI sends an acknowledgement and an error code and terminates the profile update session. If the subscriber's identity is validated, the PCI downloads the subscriber's modifiable profile elements (lines 362, 366, 370). Attached as Appendix C is a list of tags for modifiable profile elements. The PDA 30 acknowledges the received data (lines 364, 368, 372). The PDA starts a timer after sending the download request. If the PDA does not receive an acknowledgement or data from the PCI server within a predetermined amount of time, for example, ten seconds, it assumes that it is out of radio coverage and informs the subscriber to try again later. The PCI server 48 starts a timer each time it sends out data to the PDA 30. If the PCI server 48 does not receive an acknowledgement from the PDA 30 within a predetermined time, for example ten seconds, it will abort the profile download operation.

Once the subscriber finishes editing the profile on the PDA, a profile upload request is issued. An illustrative example of the message flow between the PDA 30 and the PCI server 48 for a profile upload is shown in FIGS. 20(*a*) and (*b*). After the subscriber issues a profile upload request, the PDA 30 sends an upload request to the PCI server 48 requesting permission to send the updated profile elements (step 374). The PCI server 48 validates the identity of the subscriber, for example by checking the subscriber ID and password, and checks if there is an associated download request issued by the same subscriber. The check for an associated previous download request is necessary so that the PCI server 48 is sure that the profile the subscriber wants to change is the profile that the PCI server 48 has just sent. If the subscriber's identity is not validated, or there is no associated download request packet, the PCI server sends an error code to the PDA 30 and terminates the profile update session. If the subscriber's identity is validated and there is an associated download request, the PCI server 48 honors the request by sending an acknowledgement and a status code of "OK" to the PDA 30 (line 376). When the PDA 30 receives the OK, it formats the updated profile elements and sends them to the PCI server 48 in the same way the profile was sent to the PDA 30 during the download phase (lines 378–386). If no error is detected, the PCI server 48 sends the updated profile elements to the PCI database 44 to commit the change. After a confirmation is received from the PCI database 44, the PCI server 48 sends an acknowledgement with status code of "OK" to the PDA to confirm and conclude the profile update session (line 388), as shown in FIG. 20(*a*).

FIG. 20(*b*) is an illustrative message flow when the PCI server 48 detects errors in an uploaded profile. The upload proceeds as above (lines 390–398). If the PCI server 48 detects errors in the updated profile elements it responds with an error message to notify the subscriber about the

invalid profile element (line **400**). The PDA acknowledges receipt of the error message (line **402**). The PCI server **48** sends the invalid profile elements in a similar way as the profile was sent to the PDA **30** during the download phase (lines **404**, **406**).

The PDA **30** starts a timer when its sends out an upload request or sends out data. If the PDA **30** does not receive an acknowledgement from the PCI server **48** within a certain predetermined time, it will abort the profile upload operation and inform the subscriber to retry at a later time.

VI. Services

A. Wireless E-mail Messaging

PCI includes several wireless text message sending, receiving, and service control features. PCI's wireless text messaging services are based on three network-based capabilities:

message integration combining voice message notification, voice mail, telephone calls, e-mail, and fax;

message routing and delivery, i.e., the PCI is a wireless and wireline network gateway;

database access, i.e., subscriber profile, authentication, and validation.

The PCI uses personal communications service-integration capabilities to integrate the wireless service capabilities available to the subscriber. This is accomplished by providing the subscriber with control over the message routing and delivery by the subscriber accessible "subscriber profile" stored in the PCI. The subscriber profile contains subscriber programmed instructions on message receipt, origination, and notification. Thus, PCI operates as a messaging gateway for providing access to multiple wireline and wireless networks, while using subscriber profile information to control sending and receiving options. PCI allows wireless service providers to integrate the voice messaging, e-mail, and fax message services for one subscriber through a single telephone number. Thus, one phone number may provide a single link between the service provider and the subscriber's voice and data communications lines.

The message sending features include communications across disparate networks and broadcast communications. A subscriber may send voice mail, e-mail, and fax messages between different service providers and networks. A subscriber may also send broadcast e-mail and fax messages, which broadcasts may mix e-mail and fax messages within a single distribution list. For example, the subscriber may type a message on a PDA and send it to a distribution list over a wireless network. The distribution list may direct the PCI to deliver the message to the office as an e-mail and to a client as a fax.

The message receiving features include personal number addressing, selection of message receipt media format, selection of cross-media message notification, and selection of message screening and delivery options. A subscriber may receive voice (e.g., phone), voice mail notification, e-mail, and fax communications under a single personal telephone number. A subscriber may direct e-mail and fax delivery based on selected parameters, such as time-of-day, day-of-week, etc. A subscriber's media message notification, voice mail notification of e-mail or fax messages, e-mail notification of voice mail or fax messages, and fax notification of e-mail or voice mail messages may be delivered to the subscriber based on selected options and parameters.

Alternatively, if the subscriber's wireless terminal is not activated, e-mail messages may be automatically routed to alternate destinations as defined by the subscriber's profile. For example, the subscriber may not want to receive all telephone calls at a visiting location to avoid unnecessary interruptions and unwanted incoming call charges. The subscriber directs the PCI to send notification of phone calls to the pager and to route the call to voice mail. Once notified, the user can determine from the phone number included in the pager notification whether to call the person directly, check voice mail, or ignore the call until a later time. The subscriber may also direct which messages are to be routed to the subscriber's current serving network, which are to be sent to another network, and what media is to be used to receive certain messages. The subscriber may also designate, for example, that if the wireless terminal is off, all text messages are to be sent to e-mail and all voice messages are to be sent to voice mail.

The PCI service control features include supporting subscriber profile management, supporting personal mobility across wireless and wireline networks, and supporting wireless terminal mobility. A subscriber's profile may be updated by sending text messages from a PDA over a wireless network or DTMF (touch-tone) messages from either a wireline or wireless terminal. The subscriber may program the profile to select media for receiving and sending information; select cross media for message notification; select message screening and delivery options; select single voice mailbox storage (for subscriber's with more than one voice mailbox); and select a PCI service password. All of these options may be maintained over wireless or wireline terminals. The subscriber may automatically register and deregister a wireless terminal thus updating the subscriber's profile to receive or reroute messages as preprogrammed in the profile.

The wireless data network provides data transport between the PCI server **48** and the subscriber using a wireless data terminal, such as a PDA **30**. The wireless data network may connect to the PCI server in a variety of ways, using a variety of protocols. For example, the wireless data network may connect to the PCI using a leased line and run a proprietary protocol to connect the PCI server via standardized protocols such as TCP/IP.

Text messaging systems may be connected to the PCI server through, for example, Frame Relay, SMDS, ISDN, leased line interface, or other transport mechanism effective for supporting data communications may be used. An inter-message handling system protocol, such as X.400 (in which case X.400 gateway conversion is needed), or Internet SMTP or other protocols supported by an interworking unit terminating the data transport interface, may be used to forward messages between the PCI server **48** and the system accessing the PCI.

The PCI server will preferably support sending and receiving faxes in the T.434 format. The PCI server may also preferably support sending and receiving faxes using the simple mail transfer protocol (SMTP) supported by the TCP/IP transport protocol.

FIG. **21** shows an illustrative embodiment of a PCI service supporting text messaging systems. In this example, a subscriber has a personal computer **420** at the office connected to a local area network (LAN) **414** and an enterprise text messaging system (for example, a local network e-mail) **413**, a personal computer at home **416**, and a wireless terminal, such as PDA **30** that may send and receive messages. All of these devices are connected to the PCI. For example, the subscriber's home personal computer **416** may be connected to the PCI **40** via a modem and a wireline data network **418** over either a PSTN or ISDN.

Persons connected to the LAN may send text messages to the subscriber by using the local text messaging system without using the PCI. That is, the user of computer **420** can

send an e-mail to the subscriber's office computer **412** without entering the PCI node **40**. Because the enterprise text messaging system **413** is connected to PCI, all enterprise messaging users may send messages to and receive messages from all PCI subscribers (including those not connected to the local text messaging system **413**) by using an appropriate PCI address.

A person connected to a different enterprise messaging system, such as text message handling system **2 422**, can send messages to the subscriber on message handling system **1 413** by routing the message through the PCI Server **48**.

PCI subscribers are assigned a single personal telephone for both voice and data communication. For example, an E.164 address (i.e., a telephone number) may be assigned to a PCI subscriber to use as the single PCI address. These phone numbers may be geographically based according to current PSTN architecture, but it is also possible to use portable universal numbers. Fifteen digit number formats may be desirable to permit sub-addressing. For example, a message destined for a PCI subscriber may be addressed to the subscriber's telephone number, e.g., 201-555-5555. If an originating mail system such as a LAN mail system or third party message handling system requires a domain identifier, the originator may have to specify 201-555-5555 @ PCI, or on the Internet 201-555-5555 @ pci.net. When the PCI server **48** receives the message, it will look at the subscriber's profile stored in call process request database **222** stored in a PCI database **44** to determine how to handle the incoming message. An example of a few of the options that PCI may provide for the subscriber are to:

send the message to the subscriber's wireless PDA;

send the message to the subscriber's wireline computer at home;

send the message to the destination text messaging system at the office;

send a notification of an incoming message to the wireless data terminal and the actual message to the text messaging system.

send the message to any or all of the above;

The subscriber may send text messages over the wireless data network or wireline data network to the PCI server **48**. The PCI server **48** consults with the subscriber's profile at the PCI database **44** and forwards the message to the appropriate destination, depending on the routing destination found in the profile. Text messaging systems not connected to the PCI **40** may send text messages to PCI subscribers by using another network connected between the sender's text messaging system and the PCI subscriber's text messaging system, for example, the non-connected text message may be connected to a PCI over the Internet.

The flow for wireless messaging is now described.

The flow for a PCI subscriber receiving an e-mail message to a wireless PDA **30**, for example, is as follows. An e-mail message is sent from a wireline or wireless sender to a PCI subscriber and arrives at the PCI server **48**. The incoming e-mail contains a recipient address in the format of "201-555-5555 @ pci.net" where 201-555-5555 is the subscriber's ten-digit personal number and pci.net is the PCI server's domain name in the Internet.

The PCI server **48** checks the subscriber's service profile, either from the profile service cache **51** in the PCI server or by downloading the subscriber profile from the PCI database **44** into the cache **51** to determine how to process the e-mail message. The profile contains screening and routing information and cross media notification information. The PCI server **48** uses this information to send incoming e-mail to an actual destination address that can be a wireless, wireline, or paging address using, for instance, the UDP/IP protocol over a wireless data network; the Internet SMTP protocol over the Internet wireline network; or the Telocater Alpha Numeric Protocol (TAP), respectively. In this case, the subscriber has programmed into the subscriber profile to have the e-mail sent to a PDA **30**. The PCI server **48** receives the e-mail message and forwards it to the wireless data network programmed into the profile. The e-mail is transmitted over a wireless data network **39** for receipt by the PDA **30**.

If the e-mail cannot be delivered, the PCI server returns the e-mail to the original sender with a short description of why the delivery was unsuccessful, using the SMTP protocol.

If an e-mail message is to be delivered to an alphanumeric paging address, the PCI server translates the e-mail message into a paging message and sends the paging message to the paging network specified in the subscriber profile. The protocol between the PCI server and the paging network is the Telocater Alpha Numeric (TAP). The PCI server formats the paging message into a maximum page limit with a maximum number of characters per page. For example, the page limit may be two pages and a maximum of 256 characters per page. The PCI server does not verify whether a paging message is actually delivered by the paging service provider. It will, however, verify that the message was successfully sent to the paging service provider. Because the PCI server does not provide this verification, it is under the assumption that messages sent to a pager arrive successfully at the pager.

If the subscriber profile contains an option for voice message notification of e-mail messages, the PCI server generates and sends a digitized prerecorded voice announcement to the address specified in the subscriber service profile. The protocol used to deliver the voice message notification is the AMIS-Analog Protocol.

In this illustrative embodiment, a preferred PCI server node functions as an X.400 message transport agent or SMTP router and routes messages destined for PCI subscribers and to those destined for users connected on other systems. In the case of an X.400 message transfer agent (MTA), X.400 addresses are used to internally represent subscriber addresses. The translation from the "user friendly" subscriber addresses such as E.164 numbering to the X.400 address would be done via a look-up table (ROM or other memory device) at the PCI access module or the X.400 gateway. Destination or source addresses from users on other networks are not converted to X.400 addresses, but are left in the native address format of the sending or receiving system. An X.400 gateway address may be added to the message header, however, to allow PCI to route the message to an appropriate gateway.

The PCI server **48** is responsible for delivering a message to the subscriber listed in the destination field of the message. In a simple case, the subscriber has an X.400 or Internet mailbox accessible to the PCI via one of its access connections. Alternatively, the subscriber profile may contain forwarding addresses which route the message for delivery to unusual destinations. For example, the subscriber's mailbox may reside on another message handling system, a wireless data network, wireline data network, or PSTN destination associated with a fax machine. The delivery of such a message to a final destination is handled by an interworking unit which is responsible for doing address translation and, if necessary, format translation as defined by the subscriber profile entry.

For subject e-mail screening, the subject field is analyzed to determine if a match exists before comparing the address

field. If the subject field matches an entry on the screening list, the treatment for a matched entry will occur. That means, in this illustrative embodiment, that subject screening takes precedence over address sender screening. That is, if e-mail originated from an address that is excluded from the e-mail screening address list, the e-mail will still be delivered according to the screening criteria.

If the PDA **30** is not registered for the wireless messaging service or if the PDA **30** is out of radio coverage at the time the message arrives at the PCI server **48**, the message will be sent to the subscriber's external message storage system, such as the text message system **413**.

B. Voice Messaging

FIG. **22** shows an illustrative embodiment of a PCI service for voice mail system. The voice mail systems **430** may use the public telephone network **432** and Audio Messaging Interface Specification (AMIS)—Analog Protocol to connect analog voice messages to the PCI. Alternatively, the voice mail system may use a modem **434**, a private line **436**, or an ISDN BRI AMIS—Digital Protocol **438** to connect digital voice mail signals to the PCI.

Voice messaging systems on the PCI must be able to send a message to the PCI server **48** providing notification that the subscriber has received a voice message. The voice mail system may send this text message by using, for example, asynchronous interfaces with a modem; X.25; ISDN BRI, or TCP/IP interfaces. Preferably, the PCI server **48** supports the AMIS Analog and Digital interfaces.

The PCI voice messaging call flow is as follows. Using the AMIS-Analog Protocol the system originating the voice message sends message information to the PCI server **48** specifying the type of message to be delivered, the message length (in minutes), the originator's mailbox number, and the recipient's mailbox number. When the message arrives at the PCI server **48**, the originator's mailbox is extracted from AMIS-Analog Protocol and is compared to the subscriber's voice mailbox number stored in the subscriber profile. If the two values match, the voice message is already in the mailbox designated by the subscriber. In this case, the PCI server **48** sends a bogus error code to the originating voice messaging system using the AMIS-Analog protocol so that the voice message is rejected and is not forwarded to the PCI server **48**. The PCI server **48**, however, has header information needed to send a notification message to the subscriber, if such notification is required by the subscriber profile.

If the originator's mailbox does not match the subscriber's voice mailbox number, the PCI server **48** analyzes the message length parameter. If this parameter exceeds a certain predetermined length, for example three minutes, the PCI server **48** sends a response message to the originating voice messaging system with an error code specifying that the message is too long. No further processing of the voice message occurs. If the message length is not longer than the predetermined time, the PCI server **48** sends a response message to the originating voice messaging system accepting the message. The originating voice messaging system will then forward the voice message to the PCI server.

When the voice message arrives at the PCI server **48**, the PCI server **48** attempts to route the voice message according to the screening, registration, and routing options contained in the subscriber profile. Using AMIS-Analog Protocol, the PCI server **48** sends message information to the subscriber's destination voice messaging system, specifying the type of message to be delivered, length of the message in minutes, the originator's mailbox number, and the recipient's mailbox number.

For voice messages that cannot be delivered to the destination, for example if the mailbox is full, the destination system sends a non-delivery notification message to the PCI server **48** specifying the reason why the message is undeliverable. The PCI server **48** retries delivering for up to a system defined time period. If all of the retries fail, the PCI server **48** uses the AMIS-Analog Protocol to return the voice message to the originating voice messaging system with an appropriate non-delivery notification. A pre-recorded non-delivery announcement is sent to notify the message originator that the message was undeliverable. No further processing occurs. If the destination system accepts the message, the PCI server **48** forwards the voice message to the destination system.

If the subscriber chooses e-mail notification of incoming voice messages, the notification is sent via wireless or wireline network to the subscriber as specified in the subscriber profile. If the subscriber selected page notification, the notification will be sent through the paging network according to the profile. Either notification contains the mailbox number that originated the voice message, the date and time the message was received, and the length of the voice message in minutes.

In another example, a user having a digital voice mail system creates a voice mail message and addresses it to a user of analog voice mail system. The destination telephone number indicates that the message must be routed to the PCI server **48**. The PCI server **48** checks the recipient's user profile and determines that the destination recipient has an analog voice mail system. The message is then passed into the analog voice mail system via the AMIS-Analog Protocol.

The subscriber will receive all of the voice mail messages at the voice mail system, if that is what is selected in the subscriber's profile. The subscriber may also set up the profile to receive at a wireless data terminal a text message that provides a notification of a voice mail message and envelope information of the message. Alternatively, a recipient voice mail system may send a text message containing a notification and envelope information of the message.

One feature of the AMIS-Digital Protocol is that if the original voice message is marked urgent by the sender, the AMIS-Digital Protocol includes priority status information in the message sent from the voice messaging system to the PCI server. Using this information, the PCI can screen priority messages.

The voice messaging gateway converts vendor proprietary voicemail format to the X.400 format and vice versa, thus bridging different messaging formats. It is responsible for voice transcoding from proprietary to or from X.400 form. It also maps options to or from the X.400 protocol as specified in AMIS.

C. Facsimile Messaging

FIG. **23** illustrates a PCI service for fax messaging. The PCI server **48** is connected to public switched telephone networks **432** via analog lines **444** or a T1 trunk **445**. Fax machines **440** and fax servers **442** are connected to the PSTN **432**. The PCI server **48** may also be connected to fax machines **440** and fax servers **442** by private lines **446** or an ISDN **438**. For a subscriber to receive faxes, the fax machine telephone number must be supplied to the subscriber profile. The PCI will send a fax to the designated number and may send a text notification message or take other action as the user has selected in the profile. If the user has specified a wireless data terminal to receive the fax, the PCI server **48** will perform the necessary wireless adaptation and send a fax through a wireless data terminal.

A fax may be sent to a PCI subscriber by routing the fax to the PCI node but, the user must dial the telephone number of the PCI server **48** to send the fax to the subscriber. The PCI server **48** will send the fax to the subscriber's telephone number. The PCI server will check the subscriber's user profile to determine how the fax should be delivered. In this example, the fax message is sent to a fax machine at a designated telephone number.

Fax users having existing fax machines **440** must place a call over the PSTN network in order to access the PCI. This is because existing fax machines **420**, unlike fax servers **422**, are designed for point-to-point communication, not fax network communication. Users of an the existing fax machine **420** can access the PCI in two ways. One way is by two stage dialing. The sender first dials the PCI server **48** and then dials the recipient's number after receiving a prompt from the PCI server. Alternatively, the user can dial *FX+destination address. The fax machine user can directly dial from the fax terminal the recipient telephone number proceeded by *FX, which signals the switch to automatically forward the fax call through the PCI server.

Fax servers that support X.400 messaging will include the personal number in the X.400 address field and there is no reason for the PCI server to prompt the user for the personal number.

D. CallCommand

PCI CallCommand (CC) service provides subscribers real-time control of voice calls while using a wireless data terminal or PDA. CC is designed to enhance personal number services (i.e., HLR), by providing real time call management capabilities to nomadic users.

CC provides the subscriber with four call management options:

location independence (supplementing personal number/HLR applications);

real-time call screening (using ANI and/or prompting the caller to enter a number);

real-time call redirection (routing calls to any telephone number based on the calling party); and

real-time short messaging (inputting or selecting a short message to be played to the caller).

When a caller dials a PCI subscriber's telephone number, the caller's telephone number is entered for screening. After the caller's number is entered, the PDA **30** can map the calling number to a name and alert the subscriber of an incoming call. The PDA **30** visually displays the name and/or number of the caller. The subscriber can then use the PDA **30** to accept the call by entering the telephone number of a nearby telephone to which the call will be routed. The subscriber can alternatively have the call forwarded to another number, such as a colleague's phone or a voice mailbox. If the subscriber decides not to respond to the caller, the caller is played an announcement and forwarded to a pre-determined default telephone number, such as a voice mail box or secretary.

CC allows the subscriber to send a brief message to the caller. Upon being alerted to an incoming call, the subscriber can select from a pre-defined list of messages, or type a new message, on the PDA **30**. The message is transmitted to the PCI server **48** which converts the text message into speech and plays the message to the waiting caller. The caller receives the message and can leave voice mail for the subscriber, or be forwarded by the subscriber to an alternate telephone number.

Call command enables nomadic subscribers to manage, in real time, incoming calls using screening, rerouting and messaging to the caller. Call command subscribers having a PDA **30** are visually informed of the name and/or number of the caller. The subscriber can elect to either accept the call, routing it to a specified number, such as the number of a nearby telephone; route the call to an alternate number, such as a voice mailbox, colleague phone number or secretary phone number; or respond to the caller with a brief keyed in message, which is played back to the caller in synthesized speech. The service also provides a number of non-real time call management features including predetermined screening lists, day of week/time of day routing schedules; and location sequencing. Call command allows mobile subscribers to manage and receive telephone calls using a personal digital assistant.

Call command users pre-subscribe to a wireless data service such as Ardis or RAM mobile data for E-mail, call management, and other wireless data applications. The wireless data provider provides a radio interface to the subscriber's PDA **30**. A local exchange carrier interfaces with the wireless data provider over a PCI interface. When a caller enters his or her number the local exchange carrier forwards a data message containing the caller party information. The wireless data provider locates the subscriber and forwards the calling party information to the subscriber's PDA **30** where the subscriber is alerted of the call. The subscriber then forwards the data packet containing a routing number to the PCI. The PCI reroutes the call accordingly.

FIG. **24** is an illustrative example of a CallCommand service network. A caller, Joe **450**, wishes to speak with Mary. Mary, who is away from the office, is a PCI subscriber having the CallCommand service. She has a PDA **30**, which is turned on and registered at a visiting location. Joe dials Mary's office phone number. This phone number connects Joe's call to the PCI server **48**. The PCI server **48** network instructs Joe to type in his telephone number. The PCI server **48** puts Joe on hold and plays back a message using synthesized speech informing Joe that the network is trying to locate Mary. The network recognizes that Mary is registered at a visiting location and sends a phone notification over a wireless data network **39**. Mary is notified on a PDA **30** that a phone call is coming from a particular phone number. If Mary has already programmed a name corresponding to that phone number in a directory on her PDA **30**, that name will also appear. Therefore, she is aware that she has a phone call from Joe Smith. Mary has several options. She may type or select a preselected message to be sent from the PDA **30** to the PCI network which converts the message into synthesized speech and play it back to Joe; she may forward the call to a nearby telephone, such as a cellular phone or a nearby pay phone **452** or forward the call to her secretary or colleagues's phone number; she may send a message and forward the call; or she may direct the call to her voice mail. In this illustration, Mary selects that the call be routed to a local public pay telephone **452**. The call is routed over public switched telephone networks **432** to the selected telephone and Mary and Joe speak.

CallCommand has several advantageous features. Call command includes real time call screening which allows the subscriber to direct calls in a predetermined fashion based on the caller, the time or date, etc. Call command also has real time call rerouting which allows the subscriber to reroute calls to any phone number on a per call basis. That is, when a call is received, the subscriber may enter a phone number to which she wishes the call to be routed. For example, it may be a phone in an office she is visiting, a rented cellular phone, or a public telephone. In the event that a subscriber cannot respond to a caller because PDA is out

of range, the subscriber is preoccupied, the PDA is turned off, etc., the subscriber may select a default routing number. Such a default number could be a voice mailbox, secretary, colleague, or other phone number.

Call command also has a call messaging option. This allows the subscriber to send a brief message to a calling party. The message is typed on the PDA **30** and sent by wireless means to the PCI. The PCI converts the signal into synthesized speech and plays it to the caller. For example, a subscriber may be on an important customer call when his supervisor calls, expecting a response. The call command subscriber can send a message to the manager ("Talking to customer, call you back"), while still communicating with the customer.

The call messaging feature has two aspects. The first is the wireless messaging from the PDA **30** to the PCI. The second is the text to speech translation. The subscriber may type in a message on the PDA **30**. The message originates as a data message from the wireless data provider network and is forwarded to a local exchange carrier network over the PCI interface. The PCI server **48** translates the wireless text message into speech and plays it back to the caller.

Call command also has a predetermined call management option. This feature allows a subscriber to have unanswered calls sent to predetermined default telephone numbers. For example, in the event a call cannot be answered, it is first routed to, for example, a service hotline; if the service hotline does not answer, it is forwarded to a secretary; and if the secretary does not answer, then it is forwarded to voice mail. Each time the call is forwarded to the next number a message is played back to the caller. The routing numbers and sequence order may be altered by updating the subscriber profile in the PCI database.

This feature also allows the subscriber to predetermine the management of certain numbers. For an example, a subscriber may want to be notified in real time only if a calling party number matches that of an immediate family member, supervisor, or important client. In other cases, the subscriber may wish to have calls automatically rerouted to a default number, such as a voice mailbox or secretary. For a company which does business over a large geographic area, the subscriber may wish to have the phone call routed to different places based on the geographic origin of the call. For example, calls originating from New York or New Jersey may be routed to a sales representative for that area and calls originating from California are routed to a sales representative for that geographic area.

The call management feature allows the subscriber to predetermine call routing based on the time of day. For example, a subscriber may wish to have calls forwarded to a customer service staff during business hours and be personally notified of calls during non-business hours.

Wireless technologies make subscribers constantly available, therefore it is important to give them the ability to accept or decline communication attempts at their discretion. While delivering the calling number to the PDA **30** allows a subscriber to locally screen each attempt as they occur, the subscriber may be in an environment where distractions are unacceptable such as an important meeting. Therefore, the subscriber is able to create lists against which callers are screened by the network delivering the service. These network resident lists reduce the number of call attempts to the subscriber's remote wireless device. The CallCommand service allows subscribers to turn screening on and off and add or remove numbers and names from these lists.

Like the wireless data services, CallCommand service profile management allows subscribers to modify or update their subscriber profiles which preferably reside in a PCI database **44**. Profiles are created and deleted by the service integrator controlled by the service provider. A subscriber may modify the profile by either wireless or wireline messaging using DTMF tones or data.

The subscriber profile can be updated by a wireless device such as a PDA **30**. A subscriber profile may be modified by wireline communications as well. A subscriber may use a telephone or wireline data terminal to contact an PCI database **44**. The PCI server **48** acts as a mediation device between wireless terminals and an PCI database **44** for DTMF profile updates. It is preferable that the wireline network be supported by a service management operating system capable of prompting subscribers using a DTMF telephone for a profile update that is completed when the service management operating system makes the appropriate changes in the subscriber's profile in the PCI database **44**. When a service management operations system is used to modify the profile in the PCI database **44**, the changes should also be reported to PCI server **48** so that the service profile cache **51** may be modified accordingly.

Call command has its locus of control in service logic in the PCI database **44**. The PCI database **44** service logic provides (1) service status maintenance, which maintains the status of the subscriber as registered or deregistered; (2) call screening, which provides network based screening of incoming calls; (3) call routing, which provides routing destinations for each call; this information is based on information received from the subscriber in real time via the PCI server **48** or by preprogrammed instructions in the subscriber profile in the PCI database **44**; (4) profile management support, which is service logic in the PCI database which permits "downloading" of the subscriber's profile to the PCI server **48** for presentation to an update by the subscriber through the PDA **30**; (5) security, wherein subscriber authentication and validation must be supported to safeguard the subscriber's personal information and status such as location; and (6) accounting management wherein, the PCI database **44** collects accounting parameters to support service provider billing.

The subscriber profile in the PCI database **44** must contain certain information. This type of information includes a subscriber identifier; subscriber authentication information; wireless data provider parameters; registration status; service mode (default, override, or command); screening lists; and routing tables (including day of week and time of day parameters).

The application supporting the CallCommand server in the PCI server **48** includes a mobility management function. The mobility management function provides status location information to a database in the PCI database **44** and is responsible for delivering a Temporary Location Destination number on request from the PCI database **44**. To do this, the PCI server **48** is responsible for (1) location registration, the PCI server **48** updating the PCI database **44** with the subscriber's PDA **30** status (for example, registered on a wireless data network or registered on a wired telephone); (2) play announcements and digit collection for caller information and presentation to the subscriber; (3) remote alerting, such as formatting and sending call information through a wireless data network to the PDA **30** for presentation to the subscriber; (4) profile management support (the PCI server **48** must support the "downloading" of the subscriber's profile and packaging for presentation to update by the subscriber through the PDA **30**); (5) security (the subscriber authentication invalidation information must be supported to safeguard the subscriber's personal information

and status such as location); and (6) account management (the PCI server should collect accounting parameters for presentation to the service provider for billing).

VII. Message Flows

PCI wireless messaging involves three types of message flow. The first is sending a message from one subscriber to another, the second is receiving a message regardless of whether the subscriber is using a wireless or wireline terminal, and the third is sending a message to a non-subscriber.

FIG. **25** is an illustrative example of the message flow of a PCI wireless subscriber sending a message. The PCI user submits a message **502**. The message is received by a message transfer agent in the PCI server. The MTA copies and temporarily stores the originating and destination addresses **504**. The MTA sends to the mobility manager function in the PCI server a request to validate the sending user as a PCI subscriber **506**. The mobility manager sends this validation request to the PCI database and waits for a response **508**. Upon receipt of an affirmative validation from the PCI database, the mobility manager sends the validation response to the MTA **510**. **512**. The MTA then sends the mobility manager a request for the address of the user's home MTA **514**. The mobility manager routes this request to the PCI database **516**. Upon receipt of a response from the PCI database, the mobility manager routes the home MTA address to the MTA **518**. **520**. The MTA then routes the message to the home MTA **522**. If a third party PCI database must be consulted, the home MTA request will be directed from the PCI database to a third party PCI database **524**. **526**.

FIG. **26** illustrates an example of the message flow of a wireless PCI user receiving a message. When the PCI receives a message from a subscriber, the MTA in the PCI server copies and temporarily stores the destination address and the message **530**. The MTA sends to the mobility manager function in the PCI server a request for the PCI subscriber's user profile **532**. The mobility manager will retrieve this profile request from the PCI database **534** (If third party PCI database is involved, the local PCI database contacts the third party PCI database through a switch transfer point **536**. **538**.) Upon receipt of the subscriber's profile from the PCI database **540**, the mobility manager requests the message from the MTA using a "message forward request" message **542**. When the mobility manager receives the message from the MTA **544**, the mobility manager processes the message as indicated by the subscriber's profile, which may involve media conversion or screening **546**. After processing the message, the mobility manager sends the message to the MTA for delivery **548**. **550**. Alternatively, the PCI server mobility manager function may directly deliver the message to the termination receiver **552**.

FIG. **27** illustrates an example of a message flow from a PCI wireless subscriber to a non-subscriber. When the MTA receives a message from a PCI subscriber **560**, the MTA copies and temporarily stores the originating addresses and the message **562**. The MTA sends the mobility manager a request to validate the originating address as a PCI subscriber **564**. The mobility manager will send this validation request to the PCI database and wait for a response **566**. When the mobility manager receives an affirmative validation response from the PCI database **568**, the mobility manager sends the validation response to the MTA **570**. Next, the mobility manager sends to the PCI database a request for the PCI subscriber's profile **572**. Upon receipt of the subscriber's profile from the PCI database **574**, the mobility manager requests the message from the MTA using a "message forward request" **576**. Upon receipt of the message from the MTA **578**, the mobility manager processes the message as indicated by the user's profile, which may require media conversion or obtaining the addresses for the distribution list for the message **580**. After processing the message, the mobility manager sends the message to the MTA for delivery **582**. **584**. Alternatively, the MTA may directly deliver the message **586**.

VIII. The PDA Application

To better understand the capabilities of PCI and PDA/PCI server interface, a discussion of the PDA user interface is helpful. The user interface is application software residing in the PDA. This software is described by describing the screens displayed on a PCI subscriber's PDA screen. The following discussion is for an illustrative embodiment of the PDA user interface. A person skilled in the art recognizes that the interface may be implemented in a myriad of ways.

FIG. **28** is an illustrative example of a PDA user interface main menu. The menu allows the user to enter the CallCommand or wireless messaging services, update the user profile, or check the status of the system by clicking on buttons **610**, **612**, **614**, **616**, respectively.

FIG. **29** shows a computer screen after "status request" **616** is selected. The status request screen shows that there are five local originating messages (waiting to be sent by the PDA) and three outgoing messages (waiting to be retrieved) in boxes **618**, **620**, respectively. The various services' status is also displayed. As seen in FIG. **29**, this subscriber's wireline registration is on, as seen in box **622**. This registers the subscriber on a particular wireline telephone, seen in box **624**. This registration will direct calls to this phone number. The status request also advises this subscriber about the status of the CallCommand and wireless messaging features, as seen in boxes **626**, **628**.

FIG. **30** illustrates an exemplary screen if the subscriber clicks "Call Command" **610** on the main menu (FIG. **28**). If the subscriber clicks on "YES" **630**, a screen such as FIG. **31** appears. The screen includes a window **632** which shows the status of various received telephone calls. The status indicates whether an incoming call was answered, forwarded to another number, was hung up before being answered; unanswered; or forwarded to voice mail. The phone number and receipt time and date of each call are displayed. The subscriber may save or delete any entry the subscriber by clicking box **634** or **636**, respectively. The subscriber may also connect or disconnect the CallCommand service by clicking box **638**, **640**, respectively.

FIG. **32** is an illustrative example of a screen if the subscriber selected "Wireless Messaging" **512** on the main menu (FIG. **28**). The subscriber will be connected to the wireless messaging service if "YES" **642** is clicked.

FIG. **33** is an example of a screen which may appear if the subscriber selected "Profile" **614** from the main menu (FIG. **28**). If the subscriber selects "Fax" **644** from this screen, a screen such as that shown in FIG. **34** may appear, which allows the subscriber to enter a phone number into box **646** to which faxes will be directed. Turning on e-mail screening activates both the subject and address screening. Subject screening takes priority over address screening parameters.

If the subscriber selected "e-mail" **648** on the screen FIG. **33**, a screen such seen in FIG. **35** appears. The subscriber can select where e-mail messages should be delivered (destination screening) **650**, where notification of e-mail receipt should be delivered (notification screening) **652**, whether messages should be screened at all **654** and, if so, how they should be screened **656**, **658**.

The destination **650** allows the subscriber to select destinations for incoming e-mail. Messages that satisfy the

screening requirement may be sent to two destinations (match A, match B). As shown in this illustrative example, e-mail received which match the subscriber's preprogrammed screening criteria are to be delivered only to a wireline e-mail, such as the subscriber's personal computer at the office, because match A **660** and match B **662** designate the same destination. All received e-mail messages which do not meet either criteria ("not matched") are sent to a selected fax machine **664**, for example, the fax machine at the subscriber's office.

The subscriber also indicates where notification of a received e-mail should be sent **652**. Notification for all e-mail messages meeting the screening requirement should be sent to a selected fax machine **666**. The PCI network will select information about the e-mail origination such as the author, recipient, and subject matter and convert it to a facsimile format and send the message to a fax machine. Notification of all e-mail that does not meet the screening criteria are sent to a pager **668**. The PCI network will take the originating message information and turn it into alphanumeric information according to the TAP protocol and send it to the subscriber's pager. If the screening option is turned off, notification of all incoming e-mail is sent to voicemail **670**. The PCI network will convert the origination information from text to synthesized speech and send the information to a selected voice mailbox.

The user may also select whether to screen incoming e-mail messages at all **654**. If the screening is on, the user may screen e-mail based on the originating address **656** or subject matter **658**.

FIG. **36** is an illustrative screen which the subscriber may use to edit e-mail screening according to address by clicking box **656** (FIG. **35**). The subscriber may input new e-mail addressees into box **672** and add them to a list by clicking a box **674** or select addresses already entered to be included in a screening criteria as seen in box **676**. For example, the user may want e-mail messages originating from the following addresses to be routed according to the screening criteria: cc!stanp, cc!rizzo, and cc!rupin. E-mail messages originating from these addresses will be routed and notified according to the criteria selected on the screen illustrated in FIG. **35**.

If the user selected to edit the "subject" a screening criteria based on "subjects" by clicking box **658** (FIG. **35**), a screen such as that illustrated in FIG. **37** is presented. The user may type in to boxes **678** particular subjects which should be routed according to a screening criteria. The subject will search the incoming e-mail origination information to determine the subject of the e-mail. Subjects may include "urgent", "personal", the name of a client or project, etc.

If the subscriber viewing the "profile menu" (FIG. **33**) clicked "voice mail" **680**, a screen such as that illustrated in FIG. **38** is presented. The subscriber can type into a box **682** in the destination voice mail system phone number. The subscriber may also select notification based on certain screening criteria **684**. If the incoming voice mail message matches the screening criteria, the subscriber has selected to be notified by a message sent to the PDA **686**. If the voice mail message does not match a screening parameter, the subscriber has selected to not be notified **688**. If the screening option is turned off, the subscriber has decided to not be notified of any voice mail messages **690**.

The user has the option of turning the screening on or off **692**. If the screening is on, the messages are screened by caller **694**. If the user decides to screen by caller by clicking box **694**, a screen such as illustrated in FIG. **39** is displayed. The user may type into boxes **696** certain incoming phone number which meet the screening parameters.

If the subscriber viewing the "profile menu" (FIG. **33**) clicked "Call Command", **698** a screen such as illustrated in FIG. **40** is displayed. The subscriber may type in a box **700** a wireline registration telephone number, which is a number to which incoming calls may be forwarded. The subscriber has the option to edit screening criteria phone numbers or to edit reply messages to be sent to the caller.

If the subscriber wishes to edit forwarding call numbers box **702** is clicked and a screen such as illustrated in FIG. **41** is displayed. The user may type into boxes **704** or select certain phone numbers which are to be forwarded to a preselected phone number if screening is on.

If the subscriber viewing the "Call Command" screen (FIG. **40**) clicked "edit messages" **706**, a screen such as illustrated in FIG. **42** is displayed. The user may compose a unique message in box **708** or edit one already on a list shown in box **710**.

If the subscriber has connected the Call Command and an incoming call is received, a screen such as that illustrated in FIG. **43** is displayed. This screen displays in a box **712** the number from which the incoming call originates. The user has the option of sending a message and forwarding the call by clicking box **714**, forwarding the call without a message by clicking box **716**, sending a message and not forwarding the call by clicking box **718**, or routing the call to voice mail by clicking box **720**.

If either the "message and forward" or "forward" **716** option is selected, a screen such as that illustrated in FIG. **44** is displayed. This allows the subscriber to select one of several the preselected phone numbers **722–728** to forward, or select another phone number, such as a nearby telephone to which the call is to be forwarded. This phone number may be typed into a box **730**.

If the user selected the "message and forward" **714** or "message only" **718** selections, a screen such as that shown in FIG. **45** is displayed. This allows the subscriber to type in a message into a box **732** or select a predetermined message shown in box **4134** to be sent to the incoming caller. This message is sent by wireless communications to the PCI network where the ISP converts the message into synthesized speech and plays it for the caller. For example, if the subscriber desires to call back the incoming caller as soon as possible, the message "will call back ASAP" is selected. This message is transmitted from the PDA by wireless communications to the PCI network. The ISP will receive the message and convert it to synthesize speech and send the synthesize speech message to the incoming caller.

IX. Billing

Billing operations is supported by an Automatic Message Accounting Network Function. The automatic network accounting measures, collects, formats and outputs network usage information to upstream billing and other operation application and service purposes. Preferably, automatic message accounting data is collected at various stages of service flows across network equipment and services.

X. Conclusion

A system has been described which enables a wireless PDA user to remotely control a large number of messaging and call handling options.

While the invention has been described by the reference to specific embodiments, this was for purposes of illustration only and should not be construed to limit the spirit or the scope of the invention.

APPENDIX A

Glossary of Acronyms

AIN	advanced intelligent network
ANI	automatic number identification
APS	alphanumerical paging server
ATM	asynchronous transfer mode
BRI	basic rate interface
CC	Call Command
CCDB	call contact database
CO	central office
CPE	consumer premises equipment
CPR	call process request
D&R	data and report database
DRS	data and report subdivision
DTMF	dual tone multiple frequency
GDI	generic data interface
HLR	home location register
IP	intelligent peripheral
IPI	intelligent peripheral interface
ISDN	integrated signaling digital networks
ISP	intelligent services peripheral
LEC	local exchange carrier
MOC	maintenance and operation console
MS	mail storage system
MSAP	multiple services application platform
MTA	message transfer agent
PCI	personal communications internetwork
PDA	personal digital assistant
POP	post office protocol
PPSN	public packet switched network
PSTN	public switched telephone network
SCP	service control point
SMDS	switched multimegabit digital service
SMS	service management system
SMTP	simple messaging transfer protocol
SNI	service network interface
SPACE ©	service provisioning and creation environment
SPC	service profile cache
SSP AT	service switching point access-tandem
TAP	telocator alphanumeric protocol
TCAP	transaction capable application program
TCP	transaction capable processing
VLR	visiting location register

APPENDIX B

PCI Profile Element	GDI Tag ID	Type and Max Length
Personal Data (1)		
Subscriber ID Number	1	d10
Password	2	c8
E-mail Address	3	c32*
V-Mail System Phone Number	4	d10
V-Mail System Mailbox Number	5	d10
Paging Terminal Phone Number	6	d10
Paging PIN	7	c8
Mail Storage Account ID	8	c32*
Mail Storage Password	9	c8
Wireless Provider Subscriber ID	10	c10
Wireless Voice Phone Number	11	d10
Fax Number	12	d10
Profile Version Number	13	n4
Call Command Service Profile (2)		
Call Command Registration Status	21	c1
Wireline Registration Number	22	d10
E-Mail Routing (3)		
Primary Destination 1	31	c1
Primary Destination 2	32	c1
Primary Notification 1	33	c1
Secondary Destination	34	c1
Secondary Notification	35	c1
Default Destination	36	c1

APPENDIX B-continued

PCI Profile Element	GDI Tag ID	Type and Max Length
Default Notification	37	c1
E-Mail Subject Screening (4)		
E-Mail Screening Status	41	c1
Subject1	42	c1
Subject2	43	c1
Subject3	44	c1
Subject4	45	c1
Subject5	46	c1
E-Mail From Screening (5)		
E-Mail Screening Status	41	c1
From1	52	c12
From2	53	c12
From3	54	c12
From4	55	c12
From5	56	c12
From6	57	c12
From7	58	c12
From8	59	c12
From9	60	c12
From10	61	c12
From11	62	c12
From12	63	c12
From13	64	c12
From14	65	c12
From15	66	c12
Voice Mail Profile (6)		
V-Mail Screening Status	71	c1
From1	72	c12
From2	73	c12
From3	74	c12
From4	75	c12
From5	76	c12
Primary Destination	77	c1
Primary Notification 1	78	c1
Secondary Destination	79	c1
Secondary Notification	80	c1
Default Destination	81	c1
Default Notification	82	c1

APPENDIX C

Tag	Description
001	Password for subscriber registration
002	Password for retrieval of messages from message store
003	FAX Machine Number
004	Call Command Status flag (1 = ON and 0 = OFF)
005	Wireline Registration Number for remote call forwarding
006	E-mail screening status flag (1 = ON and 0 = OFF)
007–021	E-mail "From" screening 1 through 15
022–026	E-mail "Subject" screening 1 through 5
027	E-mail Destination A - Screening Criteria Match
028	E-mail Destination B - Screening Criteria Match
029	E-mail Notification - Screening Criteria Match
030	E-mail Notification - Screening Criteria No Match
031	E-mail Notification - Screening Criteria Not Match
032	E-mail Notification - Screening OFF
033	Voice-mail Screening Status Falg (1 = ON and 0 = OFF)
034–038	Voice-mail "From" Screening 1 through 5
039	Voice-mail "Urgent" Flag (1 = ON and 0 = OFF)
040	Voice-mail Notification - Screening Criteria Match
041	Voice-mail Notification - Screening Criteria Not Match
042	Voice-mail Notification - Screening OFF

We claim:

1. A personal communication internetwork for sending and receiving wireless and wireline messages, said internetwork comprising

(1) a server, including:

(a) a message transfer agent interfaced with at least one wireline data network;

(b) a wireless data network protocol handler connected to the message transfer agent and interfacing with at least one wireless data network;

(c) a mobility controller, including

i. a subscriber profile cache;

ii. a message router responsive to message routing parameters in the subscriber profile;

iii. an interface connected to exchange message routing parameters between the subscriber profile and the at least one wireless network;

iv. an interface connected to exchange message routing parameters between the subscriber profile and a personal communication control point; and

v. an interface with at least one of a telephone network, an alphanumeric pager network, and a voice peripheral; and

a personal communication control point connected to the server, including:

(a) a first interface connected to exchange message routing parameter signals with the server;

(b) a second interface connected to exchange generic data message routing parameter signals with the server;

(c) a subscriber profile connected to receive and maintain message routing parameters; and

(d) a call processor connected between the subscriber profile and the first and second interfaces.

2. The personal communication internetwork of claim 1, wherein the internetworking is built on an Advanced Intelligent Network architecture, the server is an Intelligent Peripheral, and the control point is a Service Control Point.

3. The personal communication internetwork of claim 1, further including a personal digital assistant having a wireless data network interface connected to exchange message routing parameters and an application designed to communicate with the interface to receive, update, and transmit the message routing parameters.

4. The personal communication internetwork of claim 1, wherein the server further comprises:

a message converter connected to receive from an interface a message in a first format and output to another interface the message in a second format.

5. A method for providing personal communication services to a called subscriber who can receive any of an electronic mail, facsimile, and a voice mail message under a single address regardless of the format of the message from a calling subscriber who can send messages in more than one format and on either a wireless or a wireline network, said method comprising the steps of:

storing in a service provider database common to a plurality of subscribers and connected to both the wireless and wireline networks and responsive to inputs from the subscribers a called subscriber profile for each of said subscribers, said profile containing message routing commands for each called subscriber depending on the format of the message;

receiving any of an electronic mail, a facsimile, and a voice mail message addressed to a particular called subscriber at said particular called subscriber's single address from a calling subscriber on either of the wireless and wireline networks;

determining from the stored called subscriber profile the message routing commands for routing the received message to the particular called subscriber dependent on the format of the message;

responsive to a message routing command, converting the received message from the received format to a different format; and

routing the received message in said different format to any of a wireless or a wireless network according to the message routing commands in the called subscriber profile.

6. A personal communication internetwork for sending and receiving wireless and wireline messages between subscribers in different formats, each subscriber having a single address to which all incoming messages are addressed regardless of the format of the message, said incoming messages including at least a plurality of telephone, pager, facsimile, voice mail, and electronic text communications, said internetwork including:

means connected to receive and transmit messages in more than one format from a calling party over wireless and wireline communication networks;

means common to the subscribers and connected to said wireless and wireline networks for storing for each subscriber a profile responsive to inputs received from each of the subscribers and configured to store routing commands including communication forwarding options for said each subscriber depending on the format of the message from the calling party; and

a communication router connected to receive the received messages from the wireless and wireline networks and being responsive to the profile in said storing means for transmitting the received messages over the wireless and wireline networks according to the stored forwarding options, said communication router including a media format translation device configured to translate a received communication into a different communication medium for transmission.

7. The personal communications internetwork of claim 6 further including a server connected to said means for storing a profile for each subscriber, said server including a processor and said processor including an interface with at least a plurality of said means for storing a profile, a wireless data network, an alphanumeric paging network, a telephone network switch, and a text-to-speech voice peripheral.

8. The personal communications internetwork of claim 6 wherein said communication router further comprises an audio messaging interface specification analog protocol connected to at least one of a modem, a private line, and an integrated signaling digital network basic rate interface.

9. A method for personal communications comprising the steps of:

storing a subscriber profile containing message routing commands for a subscriber:

receiving any of an electronic mail, a facsimile, and a voice mail message addressed to the subscriber from either of a wireless and a wireline network;

consulting the subscriber file for instructions for routing the received message; and

routing the received message to any of a wireless or wireline network according to the instructions in the subscriber profile; and wherein said step of receiving a voice mail message addressed to the subscriber further includes the steps of:

receiving from an originating voice mail system an incoming voice mail message call at a network, said voice mail message call including identification information;

extracting the identification information from the message to determine the origin of the voice mail message;

consulting a profile contained in the network to determine routing instructions, said routing instructions including one of:

(i) routing the incoming call to a preselected telephone number; and

(ii) sending a notification to the subscriber of the incoming call via a medium other than a telephone call;

routing the received voice mail message according to the routing instructions in the profile;

said step of consulting further comprising determining if the identification of the originator indicates that the originator is also the subscriber;

if the originator is the subscriber, said step of routing further comprises the steps of:

(i) not forwarding the voice mail message; and

(ii) extracting header information from the identification information and transmitting a notification to the subscriber containing the header information; and

if the originator is not the subscriber, said step of routing further comprises the steps of:

(i) if the message exceeds predetermined length, rejecting the message; and

(ii) if the message is less than or equal to the predetermined length, accepting and routing the message.

10. The method of claim **9** further comprising before the step of routing, the step of translating the voice mail message from analog format into a digital format.

11. The method of claim **9** further comprising before the step of routing, the step of translating the voice mail message from a digital format into an analog format.

* * * * *